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IMPACT

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IN THIS NUMBER SELECTED TEXTS FROM

Descartes, Rousseau, d'Alembert, Condorcet, Laplace, Henri de Saint-Simon, Paul Valéry, F. Le Lionnais, Jean Rostand

AND

Science and Society

ABSTRACTS

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FOREWORD

Science and Society French Bibliography 1900-50

This double number of Impact *contains a bibliography of books or articles in French, published between 1900 and 1950 on the social effects of science. By restricting ourselves to one language only, we have been able to bring out a fuller and more balanced issue.*

The question of the interaction of science and society may be considered from a variety of different angles. There is, firstly, the historical approach, based on the main chronological divisions of the history of science. In fact, however, this approach would have been unsuitable, since it would have meant concentrating most of the matter into a single chapter dealing with modern times, the period that has witnessed the greatest triumphs of science. Again, it is possible to take each of the classical branches of science—mathematics, physics, biology and so forth—separately, tracing its particular repercussions on the social structure. But since most of the works deal with science in general, without much reference to this kind of classification, this course would have meant grouping most of the material under a general heading, and what was left for the remaining chapters would have been too scanty and too highly specialized.

We finally decided to classify the material according to the type of influence exerted—a method much more in line with the aims of Impact. *Thus the first part of the issue contains works of a general nature, especially those dealing with the future of mankind in terms of scientific progress. There is a considerable amount of literature on this subject, including novels anticipating the future of the world—the type of book most readily available to the public. The second part is devoted to the special impact of science on human life—science and the evolution of societies, science and the developments of everyday life, science and the development of the human mind. The third part deals with the subject from the opposite point of view—the role of society in the evolution of science. The last part contains documents of historical or bibliographical interest.*

It was not easy to select the material for abstracts, for what was available was at once too copious and too restricted. French authors have written much less on this subject, particularly during the last few years, than have their Anglo-Saxon colleagues; and they have approached the problems raised by the modern expansion of science from a speculative rather than from a practical point of view. As a result, we have a wealth of works of a mainly philosophical character, as against a very few which deal, in a concrete way, with the role played by science in twentieth-century societies. We have therefore had to include in the bibliography a number of works (in our view, of too general a nature) on psychology, philosophy, or sociology, for instance, which, though not mainly concerned with the social aspects of science, contain several important pages or chapters thereon. On the other hand, we have occasionally mentioned somewhat specialized works which would certainly have been included in other special numbers. We have even included some works whose abstracts would seem to indicate that they scarcely touch on the matter in hand at all, but which, owing to their special standpoint, appear to throw interesting light on it. Finally, we have mentioned translations of foreign works giving the French reader information on this subject. We fully realize that certain omissions are inevitable; and we regard this particular series as a bibliographical guide rather than as a complete bibliography.

The subject itself is hard to define. Where, after all, does the impact of science on society begin, and where does it end? We have, at all events, carefully eliminated all works confined to pure logic or pure method, works on scientific truth, or works on research methods. Some surprise may be felt at the presence of works whose conclusions have proved highly debatable; but our action here is justified by the influence they have exerted on the present-day world, or the position they occupy in contemporary thought.

As in every number of Impact, *the abstracts are preceded by extracts, selected this time from French authors only. It was in the eighteenth century, and primarily in France, that the idea of the infinite possibilities of science and its benefits*

to humanity began to gain ground. This movement, which began with the Encyclopaedists, developed till about the middle of the nineteenth century and reached its maturity in Positivism, the culmination of the belief in the beneficient powers of science. From the outset, however, this passionate faith in the scientific future of mankind has been opposed, sometimes mutely but sometimes very vocally, by another tendency—a tendency to regard science and reason as the source of all our ills, the cause of the fall of man and of the decay of societies. Rousseau's diatribes, often naïve enough, are echoed, in our own day, in the subtle analyses of Bergson and numerous others who regard the series of setbacks to modern society as proof of the "bankruptcy" of science. We have endeavoured, both in the pages which follow and in the abstracts themselves, to present certain aspects of these two conflicting trends of thought. It is interesting to note that it is only when we come to contemporary works that we find authors prepared to abandon speculation and devote themselves to accurate research on the actual consequences of the development of a given science. From the stage of philosophical speculation we pass to that of philosophy of knowledge.

The Editor of Impact.

Selected Texts

Descartes and the Future of Science

". . . As soon as I had acquired some general notions concerning physics, and as, beginning to make use of them in certain special difficulties, I observed to what point they might lead us, and how much they differ from the principles of which we have made use up to the present time, I believed that I could not keep them concealed without greatly sinning against the law which obliges us to procure, as much as in us lies, the general good of mankind. For they caused me to see that it is possible to attain knowledge which is very useful in life, and that, instead of that speculative philosophy which is taught in the schools, we may find a practical philosophy by means of which, knowing the force and the action of fire, water, air, the stars, the heavens and all other bodies that environ us, as distinctly as we know the different crafts of our artisans, we can in the same way employ them in all those uses to which they are adapted, and thus render ourselves the masters and possessors of nature. This is not merely to be desired with a view to the invention of an infinity of arts and crafts which would enable us to enjoy without any trouble the fruits of the earth and all the good things to be found there, but also principally because it brings about the preservation of health, which is without doubt the chief blessing and the foundation of all other blessings in this life. For the mind depends so much on the temperament and disposition of the bodily organs that, if it is possible to find a means of rendering men wiser and cleverer than they have hitherto been, I believe that it is in medicine that it must be sought. It is true that the medicine which is now in use contains little of which the utility is remarkable; but without having any intention of decrying it, I am sure that there is no one, even among those who make its study a profession, who does not confess that all that men know is almost nothing in comparison with what remains to be known; and that we could be free of an infinitude of maladies both of body and mind, and even also possibly of the infirmities of age, if we had sufficient knowledge of their causes, and of all the remedies with which Nature has provided us. But having the intention of devoting all my life to the investigation of a knowledge which is so essential, and having discovered a path which appears to me to be of such a nature that we must by its means infallibly reach our end if we pursue it, unless, indeed, we are prevented by the shortness of life or by lack of experience, I judged that there was no better provision against these two impediments than faithfully to communicate to the public the little which I should myself have discovered, and to beg all well-inclined persons to proceed further by contributing, each one according to his own inclination and ability, to the experiments that must be made, and then to communicate to the public all the things which they might discover, in order that the last should commence where the preceding had left off; and thus, by joining together the lives and labours of many, we should collectively proceed much further than anyone in particular could succeed in doing."

Extract from **Discours de la méthode** *by Descartes.*

An Eighteenth-Century Polemic: Rousseau and d'Alembert

ROUSSEAU:

. . . our minds have become corrupted as our arts and sciences have advanced towards perfection. Will it be said that this is an evil peculiar to our times? No, gentlemen; the evils that result from our idle curiosity are as old as the world itself. Just as the daily rise and fall of the ocean waters are regularly controlled by the course of the stars that light us at night, so have morals and integrity been affected by the progress of science and art. We have seen how virtue fades away as their light appears on our horizon, and the same phenomenon has been observed at all times and in all places.

Consider Egypt, that first school of the universe, that fertile climate under a burning sky, that famous land from which Sesostris once set out to conquer the world. She became the mother of philosophy and the arts, and soon afterwards she was conquered by Cambyses, then by the Greeks, the Romans, the Arabs and finally the Turks.

Consider Greece, peopled of old by heroes who twice defeated Asia, once before Troy and once in their own country. The birth of literature had not yet sown corruption in the hearts of the Greek people, but the progress of the arts, the decay of morals and the Macedonian yoke followed in quick succession; and for Greece—learned, pleasure-loving and enslaved—revolution came to mean no more than a change of masters. All the eloquence of Demosthenes did not avail to restore life to a body enervated by luxury and art.

It was in the time of Ennius and Terence that Rome, which had been founded by a shepherd and rendered illustrious by tillers of the soil, began to decline. Then, after Ovid, Catullus, Martial and all those obscene writers whose very names are an offence to decency, Rome, once a temple of virtue, became a stage for crime, a disgrace to the nations, and the plaything of the barbarians. This capital of the world finally fell under the yoke she herself had laid upon so many other peoples, and her downfall came on the eve of the day when the title of "arbiter of taste" was given to one of her citizens.

What can be said of that metropolis of the Eastern Empire whose position seemed to mark it out for being the capital of the universe, the repository of those arts and sciences which, perhaps through wisdom rather than through barbarism, were eschewed by the rest of the world? The history of Constantinople is woven from the most shameful debauchery and corruption, treachery, assassination, the blackest poisons, the most atrocious crimes. Such is the pure source from which the light boasted by our century has emanated.

But why delve into the remote past to demonstrate a truth of which such solid proofs exist before our eyes? There is in Asia an immense country where honour in letters leads to the highest offices of the State. If it were true that science cleansed morals, that it taught men to shed their blood for their country, that it fired them with courage, the peoples of China should be wise, free and invincible. Since, however, they are a prey to every vice, since there is no crime to which they are not accustomed, and since neither the learning of their ministers, nor the so-called wisdom of their laws, nor yet the vastness of their great empire's population saved them from the yoke of the coarse and ignorant Tartar, of what use have its wise men been to China? Have the honours heaped upon them served merely to people the country with slaves and miscreants?

Thus it is that luxury, dissoluteness and slavery have always punished our presumptious efforts to emerge from that state of happy ignorance in which eternal wisdom has placed us. The thick veil in which its workings are cloaked would seem to warn us that we are not intended to seek reasons for them. But which of its lessons have profited us, and which have we been able to neglect with impunity? Peoples, you should understand once and for all that Nature has sought to preserve you from science, as a mother snatches a dangerous instrument from her child's hand; that all the secrets she hides from you are so many evils from which you are being protected, and that the difficulty you find in learning is not the least of her blessings. Men are perverse; they would be more evil still if they had had the misfortune to be born learned.

How humiliating such reflexions are for humanity! How mortifying to our pride! Can it be that integrity is the child of ignorance? that science and virtue are incompatible? What inferences can be drawn from such prejudices! Yet, in order to reconcile these seeming contradictions, we need only look closely at the vanity and emptiness of those proud titles that dazzle us and that we confer so generously upon the various forms of human knowledge. Let us consider science and art in themselves; let us see to what their progress will lead; and let us concede, without further ado, the points on which our own reasoning is in line with historical induction.

There was an old tradition, which passed from Egypt to Greece, that science was invented by a

god who disliked seeing man at rest. In what esteem, then, was science held by the Egyptians themselves, among whom it was born? The truth is that they were close enough to the sources from which it sprang to be able to see them clearly. Whether we skim through the annals of the world, or supplement doubtful records with philosophical research, we find that human knowledge has origins very different from those we like to imagine. Astronomy was born of superstition; eloquence, of ambition, hatred, flattery, and lying; geometry of avarice; physics of vain curiosity; and all, even ethics themselves, of human pride. Science and art owe their birth, then, to our vices; we should be less doubtful of their advantages if they owed it to our virtues.

The defect of their origin is all too manifest in their purpose. What would become of the arts without the luxury on which they are nourished? Of what use would jurisprudence be if men were not unjust? What would happen to history if there were no tyrants, wars or conspirators? Who, in a word, would care to pass his life in sterile contemplation if each thought only of the duties of man and the needs of nature, and had time only for his country, for the unfortunate, and for his friends? Are we created in order that we should die chained to the edge of the well into which truth has withdrawn? This reflexion alone should suffice to discourage any man who seriously seeks to acquire learning through a study of philosophy.

What dangers and false paths are opened up by the investigation of science! How many errors are involved in mastering it—errors whose danger is out of all proportion to the simple usefulness of truth! The disadvantage is clear; for falsity is possible in an infinite number of combinations, whereas truth exists in a single form alone. Does anyone, moreover, seek the truth sincerely? With the best will in the world, by what signs can we be sure of recognizing it? By what criterium, amid all these different feelings, are we to judge it? And, hardest of all, if we are fortunate enough to find it, which of us will make good use of it?

If the goal which science sets itself is useless, the effects it produces are positively dangerous. It is born of idleness and encourages it; irrecoverable loss of time is the first damage it necessarily does to society. In politics, as in morals, it is a grave fault not to do good; every useless citizen may rightly be regarded as a wicked man. Answer me, then, illustrious philosophers, you who can explain why bodies are drawn together in space: what are the proportions between the areas covered in equal times by the revolutions of the planets; which curves have conjugate points, points of inflexion and cusps; how it is that mankind sees all things in God; how the body and the soul correspond without means of communication, as two clocks might do; which heavenly bodies are inhabitable; which insects reproduce themselves in an extraordinary manner; answer me, I say, you who have imparted to us such sublime learning! If you had never taught us any of these things, should we be less numerous, less well governed, less to be feared, less flourishing, or more perverse? Reconsider the importance of your works; and if those of our most enlightened scientists and our best citizens are of so little use to us, tell us what we are to think of that host of obscure writers and idle men of letters who, to no purpose whatever, devour the substance of the State.

Extract from Discours sur les sciences et les arts, "Les grands classiques illustrés", *Rombaldi, Paris.*

D'ALEMBERT:

It may be considered that one of the main things (which tend to plunge us into a state of barbarism) is that false cleverness that protects ignorance, considers it an honour to do so and will spread it, sooner or later, universally. This barbarism will be both the fruit and the limit of bad taste; and I must add that it will also be the cure for it. For everything moves in its appointed cycle, and darkness will be brought to an end by a new century of light. We shall be all the more struck by broad daylight because we shall have walked for so long among the shadows. Those shadows will be like a sort of anarchy, highly harmful in itself but sometimes having useful results. Let us not, however, pray for so formidable a revolution; barbarism lasts for centuries, and it would seem that it is our proper element; reason and good taste are but fleeting.

This may well be the place in which to reject the accusations recently levied by an eloquent and philosophically-minded writer against science and the arts, which he considers are corrupting of morals. It would ill become us to accept his opinion at the outset of such a book as this; and the worthy man of whom we speak appears to approve of our work, since he has contributed to it with so much zeal and success. We will not reproach him for having confused the culture of the mind with the abuse that can be made thereof; he would reply, no doubt, that such abuse is inevitable; but we should like to ask him whether the greater part of the evils which he ascribes to science and the arts is not due to quite different causes, the enumeration of which would be as lengthy as it would be difficult. It is certain that literature helps to make society more agreeable; *it would be hard to prove that it causes men to become better, or virtue to be more widely spread; that, however, is a privilege to which even ethics can lay no undisputed claim. To go yet further, should all laws be abolished because they serve as shelter for certain crimes, whose authors would be punished in a republic of savages? Finally, even if we made to the disadvantage of human knowledge an admission in which we are so far from believing, we are yet farther from thinking that we should gain anything by destroying it, since all the vices would remain and ignorance would be added to them.*

Let us finish with this question of science by pointing out that the different forms of government, which have such influence over men's minds and

over literary culture, also determine the kinds of wisdom which will chiefly flourish under them, and each of which has its own particular merit. Under a republic there will generally be more orators, historians and philosophers, and under a monarchy more poets, theologians, and geometricians. This rule, however, is not so absolute that it cannot be changed and modified by an infinity of causes.

Extract from Discours préliminaire.

Science and Progress

by

CONDORCET

The outcome (of the work I have undertaken) will be to show by argument and from evidence that Nature has set no bounds to the development of man's faculties; that the perfectibility of man is in fact unlimited and that the only term to the process, freed now from every power seeking to arrest it, will be the life span of the globe where Nature has placed us. The pace of the advance may, of course, vary, but there will never be regression, at least as long as the earth occupies its present place in the system of the universe and as the general laws of that system produce on this globe neither a general cataclysm nor such changes as would preclude the human species from preserving and exercising there the same faculties and finding the same resources. . .

If there be a science to forecast, direct and speed the advance of the human species, its foundation must be the history of the progress man has already made.

Philosophy had no choice but to condemn the superstition that rules of conduct could be found only in the history of the past, and truth only in the study of our forbears' views; but should it not also proscribe the prejudiced conceit which would reject the lessons of experience? Abstract reasoning alone with the aid of happy combinations can undoubtedly arrive at the general truths of the science of man. But if observation of individuals of the species is useful to the metaphysician and the moralist, why should the observation of societies be less useful both to them and to the political philosopher? If it be useful to observe different societies existing concurrently, and to study the relationships between them, why should it be less so to study them through the ages? Even assuming that such studies can be neglected in the search for speculative truths, should they be, when it comes to applying those truths in practice and to deducing from the science the art that should be its practical issue? Do not our prejudices and the ills arising from them derive from the prejudices of our ancestors, and is not one of the surest ways of freeing ourselves from the one and parrying the other to trace out for ourselves their origins and their effects?

Have we reached a point when we need no longer fear the rise of new errors or the resurgence of old; when no corrupting institution can any more be promoted by hyprocrisy, and embraced by ignorance and wishful thinking; when no vicious combination can any more bring misery on a great nation? Is it then useless to know how the peoples have been deceived, corrupted or beggared?

Everything points to our being on the threshold of one of the great revolutions of the human species. What then is better fitted to enlighten us on what we should expect of that revolution or to serve as a sure pilot to steer us in its currents than the descriptive picture of the revolutions which preceded it and prepared the way for it? Our present enlightenment is a guarantee that the outcome will be happy; but is it not also on condition that we should be able to deploy our full strength? And for the happiness in prospect to be less dearly bought, for the revolution to spread more swiftly and more widely, for its effects to be more complete, surely we need to study in the history of human thought what obstacles we still have to fear and what means we have to overcome them. . .

The applications of the theory of probability are a token of how much they can contribute to the progress of the other sciences. They can determine the probability of the extraordinary and enable us to judge what should be rejected and what is worth verifying; they can show the likelihood of regular recurrence of these frequent phenomena met with in the practical arts of man which cannot in themselves be ascribed to any order already obedient to a general law: examples from medicine

are the beneficial effects of certain remedies and the success of certain preservatives. Again they show the probability of a body of phenomena deriving from an intention of an intelligent being, the effect of other prior or co-existent phenomena, and the probability of their being attributable to the necessary but unknown cause which men call chance, a term whose true meaning only the study of this theory can reveal.

These applications have also taught us the several degrees of certainty we can expect to reach; the weight of probability on which we are entitled to adopt a point of view and reason from it without infraction of the rights of reason and the rules of our conduct, without imprudence or without offending against justice. They show what are the advantages or disadvantages of the various forms of election, of the various ways of arriving at decisions by a majority vote; the several degrees of probability which can result therefrom; what degree the public interest must exact, having regard to the nature of the particular question; the means either of attaining almost with certainty that degree of probability where the decision is not necessary or where one of two choices whose disadvantages are unequal cannot be legitimate as long as it fails to attain such degree of probability; or those of making sure in advance of attaining that degree of probability with reasonable frequency where, on the contrary the decision is necessary and the slightest degree of probability suffices for its acceptance.

Yet another practical use is in assessing the probability of facts for those not in a position to base acceptance on personal observation, on the strength either of the weight of the evidence or the connexion of the facts in question with others directly observed.

Then how valuable is the research into human expectation of life, and the influence on this expectation of sex, temperatures, climate, profession, government and habits of life; the mortality from different diseases, population changes, the relative degree of influence of the factors causing those changes; the distribution of population in each country in terms of age, sex, and occupation, how valuable are all these studies for our physical knowledge of man, for medicine and for public economy!

Indeed, how widely has this theory been put to use in public economy, for the calculation of annuities, tontines, savings and provident funds, and insurances of all kinds!

Again, is not the use of this theory necessary for that sector of public economy concerned with the theory of measures, and of money, banks, financial operations or imposts, and with their incidence established by law, the frequently very different real incidence and their reaction on all parts of the social system?

How many are the important questions in the theory of probabilities whose solution has only been possible with the aid of knowledge acquired from natural history, agriculture, botany, mechanics or chemistry!

Briefly, the general progress of science has been such that, practically speaking, there is no single science which can be wholly grasped in its principles, in its details, without recourse to all the other sciences. . .

If we were to confine ourselves to showing only the benefits secured by the sciences either from their immediate use or from their applications to the arts, either for the well-being of individuals or for the prosperity of nations, only a small part of the good they do would have been exhibited.

Perhaps the greatest good they have done is to destroy prejudice and, as it were, uplift the human intellect forced to follow the false bent given it by the absurd beliefs instilled into the children of each generation with the terrors of superstition and the fear of tyranny.

All errors, in politics and ethics alike, stem from philosophical errors, themselves linked to false physical concepts. There is no religious system nor supernatural extravagance which is not based on ignorance of the laws of nature. The inventors, the defenders of these absurdities could not foresee the progressive perfecting of the human mind. Convinced that in their day men knew all they could ever know and would believe forever what they then believed, they confidently based their daydreams on the views prevalent in their country and their age.

Advances in knowledge of the physical world are all the more fatal to these errors in that often they destroy them without seeming to attack them, covering those who mulishly defend them with the ridicule which is the meed of ignorance.

Simultaneously the habit of reasoning correctly on the subject-matter of these sciences, the clear-cut notions given by their methods, the means of recognizing or proving truth, must lead us naturally to compare the feelings which oblige us to concur in views based on such real grounds for credibility with those which attach us to our habitual prejudices or cause us to bow to authority: this comparison is enough to teach us to mistrust the latter, to make us feel that they are not really believed even by those who boast of believing them or profess them with the utmost sincerity. Once that secret is revealed, their destruction is prompt and sure.

Lastly, this progress of the physical sciences in which passions and interest play no part, in which there is no belief that birth, profession or rank accords the right to judge what one is not equipped to understand, could not have taken place as surely, had not enlightened men in the other sciences sought to conform closely to the standards of the physical sciences. They found in them at every turn the model they should follow, by which they could judge their own efforts, realize when they had gone astray, avoid alike pyrrhonism, credulity, blind distrust, and too unreserved a submission to the authority even of intellect and repute.

No doubt, metaphysical analysis was leading to the same conclusion; but it would have given no more than abstract precepts, whereas here those same abstract precepts, put into action, were clarified by example and fortified by success.

Until this age the sciences were the heritage of

the few; already they have spread far and the time is coming when their elements, their principles and elementary methods will become really popular. It is then that their practical application in the arts, and their influence on the general soundness of minds, will be of truly universal service. . .

If man can predict with almost absolute certainty the phenomena whose laws he knows; if, even when the laws are unknown to him, he can foresee with a great degree of probability the events of the future in the light of the experience of the past, why should it be regarded as chimerical to seek to outline with some measure of probability the future of mankind in the light of the results of its history? The sole foundation of belief in the natural sciences is the idea that the general laws, known or unknown, ruling the phenomena of the universe are necessary and constant. Why then should this principle be less true for the development of the intellectual and moral faculties of man than for the other operations of nature? Lastly, since views formed in the light of past experience on matters of the same order are the sole rule by which the wisest men guide their conduct, why should the philosopher be forbidden to base his speculations on the same foundation, provided he does not claim for them a degree of certainty greater than can arise from the number, constancy and precision of his observations?. . .

We shall find in the experience of the past, in the contemplation of the progress so far made by the sciences and civilization, and in the analysis of the advance of the human mind and the development of its faculties, the strongest reasons for believing that Nature has set no limit to our hopes. . .

The body of positive truths constituted by the system of the sciences of observation, experiment or calculation can grow unceasingly; yet all the parts of the system could not improve unceasingly, were man's faculties of power, activity and scope to remain unchanged.

By applying these general reflexions to various sciences, we shall give for each examples of these successive improvements which will leave no doubt as to the certainty of those we must expect. Particularly we shall indicate, in the case of those which prejudice regards as more exhausted, the earliest and most certain of the progress we may expect. We shall enlarge on all that a more general, more philosophical, application of the sciences of calculation to all human knowledge should bring in added scope, precision and unity to the system as a whole. We shall point out how more universal education in each country, by giving to greater numbers of men the elementary knowledge which can inspire in them the taste for some form of study and the power to advance in it, must add to these hopes; and how they will become higher still if a more widely spread prosperity enables more persons to devote themselves to such occupations, since barely the fiftieth part of those naturally talented receive, even in the most enlightened countries, the education needed to develop their gifts, so that the number of those destined to enlarge the realm of science by their discoveries should increase in the same proportion.

We shall show how much this equality in education, and the equality which must be established between the nations would accelerate the advance of those sciences whose progress depends on observations in ever increasing numbers and over ever wider areas; all that mineralogy, botany, zoology and meteorology can hope from it; and, lastly, the enormous disproportion in these sciences between the feebleness of the resources which nevertheless have brought us so many useful and valuable truths and the magnitude of those which man could then employ.

We shall show how much, even in the sciences where discoveries are the fruit of reasoning alone, their pursuit by larger numbers of men may still contribute to their progress by those improvements of detail which do not require the intellectual force essential to inventors and which are the fruit simply of reflexion.

If we turn to the arts whose theory depends on these sciences, we shall see that the progress which must follow that of this theory can have no other boundaries; that the processes of the arts are capable of the same improvement and the same simplifications as scientific methods; that instruments, machines and looms will add ever more to the power and skill of men, and increase both the perfection and precision of products by decreasing the time and the labour needed to obtain them. Then will vanish the obstacles, created by accidents we would learn to foresee and prevent, and by the unhealthy conditions of work, of habits or of climates, which still block this advance.

Then an ever smaller extent of land will be capable of a heavy yield of products more useful or of greater value; lower consumption will give larger returns, and a given product of industry will either represent a smaller expenditure of raw materials or will have a longer life. Men will know how to select for each soil crops meeting the greatest needs, and between crops of equivalent range of utility those supplying the greater number with less work and less real consumption. Thus, with no sacrifice, the means of preservation and of economy in consumption will follow the progress of the art of producing the various substances, of processing them and of manufacturing goods from them.

Not only will the same area of land be able to feed more persons, but each individual among them will be at once less toilsomely and more productively employed, and will be better able to satisfy his needs.

However, with all these advances of industry and well-being bringing with them a more advantageous ratio between men's powers and needs, either through this progress or through conserving the products of a previous industry, each generation will necessarily enjoy larger resources, bringing with them, by reason of the physical constitution of the human species, an

increase in each generation of the number of individuals. That being so, will not a time necessarily arrive when these laws, equally ineluctable, come into conflict? When the increase in human numbers exceeds that of human resources, with the inevitable consequence if not of a steady decrease in well-being and population—a true regression—at least of a kind of fluctuation between good and evil? Would not this fluctuation in societies having reached this stage be a permanent cause of recurring poverty? Would it not mark a limit to any further improvement, and set for the perfectibility of the human species a boundary which it would attain in the course of centuries, but could never exceed?

Probably there is no one who fails to realize how distant is that day from ours; but is it bound to come? It is impossible to pronounce for or against the future reality of an event which would only arrive in an age when the human species would necessarily have acquired knowledge which we can barely conceive. Who indeed would dare to prophesy what the art of converting the elements into substances fit for our use may one day become?

However, even supposing that this day had to come, we need feel no fears either for the happiness of mankind or man's infinite perfectibility. If in the meantime the advance of reason has kept pace with that of the sciences and arts, and the ridiculous prejudices of superstition no longer infect morality with an austerity which corrupts and degrades instead of purifying and uplifting it, men will realize that, while they have a responsibility towards the unborn, it consists in giving them not life but happiness; it is to ensure the general well-being of the human species or that of the society in which they live, of the family to which they belong, and does not amount to the puerile notion of burdening the earth with useless and unhappy beings. Thus there might be limits to the possible volume of food supply, and hence to the maximum population possible, without this fact implying the premature extinction, contrary to nature and social prosperity, of a proportion of the beings brought to birth.

As the discovery, or rather the accurate analysis of the first principles of metaphysics, ethics and politics is still recent and was preceded by the knowledge of a large number of isolated truths, the preconceived notion readily arose that these sciences must have reached their final form. The assumption was made that nothing remained to be done, because there were no more glaring errors to be destroyed and basic truths to be established.

Yet we can easily see how imperfect the analysis of man's intellectual and moral faculties still is; how much our knowledge of man's duties, presupposing knowledge of the influence of his actions on the well-being of his fellows and of the society of which he is a member, may still be extended by more constant, more thorough and more accurate study of that influence; how many questions still remain to be resolved, how many social relationships still to be examined in order to know with accuracy the scope of man's rights as an individual and of the rights which the social organization gives to the community over each member. Have we even yet defined with any precision the limits of these rights, either between societies in times of war, of societies over their members in times of trouble and division, or of the rights of individuals, those of spontaneous union in the case of a free and primitive formation, or of a separation which has become necessary?

If we now turn to the theory which should direct the application of these principles and serve as the basis for the social art, do we not see the need for attaining a degree of precision unattainable by these general primary truths? Have we reached the point when we can show the basis of all legal provisions to be either justice or proven and recognized utility, and not vague, uncertain and arbitrary notions of alleged political advantages? Have we laid down accurate rules for choosing with certainty, from the almost infinite number of possible combinations, squaring with the general principles of equality and natural rights, those best calculated to ensure the preservation of those rights, leaving the greater scope for their exercise and enjoyment, and best ensuring the ease and well-being of individuals, and the strength, peace and prosperity of nations?

The application to these sciences of the theories of combinations and probabilities holds out the greater promise for future progress in that it is at once the only means of giving to their conclusions an almost mathematical accuracy, and of assessing the degree of certainty or probability of those conclusions. From the facts on which the conclusions are based, general truths may indeed sometimes emerge from observation alone and without the aid of mathematical processes. These facts can show whether the effect produced by a given cause was favourable or the reverse; but, if the facts themselves have been neither counted nor weighed, if the effects have not been measured with precision, then we have no means of knowing how much good or bad springs from a particular cause, or whether the one offsets the other; if the difference is small, we shall even be unable to say with any certainty to which side the balance inclines. Without the use of the calculus, it would often be impossible to choose with any certainty between two combinations designed to secure the same result, when the disproportion between their relative advantages was other than evident. Lastly, without this same auxiliary, the sciences in question would remain crude and limited for want of instruments perfect enough to discern the elusive truth, or of machines sure enough to reach the depths of the mine where part of their treasure lies.

Nevertheless, this application, despite the successful efforts of certain geometricians, is as yet no more than in its infancy, and it will open to the generations which follow a source of enlightenment as inexhaustible as the science of the calculus itself, as the number of combinations, relationships and facts to which it can be applied. . .

Is not the effect of the improvement of the laws and

public institutions, which is the sequel to the progress of these sciences, to bring nearer and identify the common interest of every individual with the common interest of the whole? Is not the object of the social art to destroy the apparent opposition between the two? Will not the country whose constitution and laws are most in conformity with what reason and nature prescribe be that in which virtue will be easiest, and temptations to fall away from it be fewest and weakest?. . .

The progress of the sciences ensures that of the art of teaching, and this in turn hastens the advance of science. This ceaseless interaction must be included among the most active and potent causes of the improvement of the human species. Today a youth leaving our schools knows more mathematics than Newton had learnt by deep study or discovered by his genius; he can handle the instrument of calculus with a facility then unknown. The same is true of all the sciences, though in a varying degree. As each of them expands, the means of compressing still more the proofs of a greater number of truths and of facilitating their comprehension improve proportionately. Thus not only do men of equal genius find themselves at the same period of their lives, despite the new advances of science, at the level of the present state of science; but with each generation, what can be learnt in a given space of time with a given intellectual power and degree of attention will necessarily increase, and the elementary part of each science, that to which all men can attain, becoming ever more extensive, will comprise more fully what each may need to know to guide his steps in community life and to exercise his reason in full independence.

In the political sciences there is an order of truths which, particularly among free peoples (that is, among all peoples in a few generations), are of use only when they are generally known and acknowledged. Thus the influence of the progress of these sciences on liberty and on the prosperity of the nations must in some sort be measured by the number of those truths made common be elementary education to all minds; hence the ever-growing advance in elementary education, itself linked to the necessary progress of these sciences, holds out to us the prospects of a future progress of the human species which can be regarded as infinite, since it has no other bounds than those of scientific progress itself.

Extract from Esquisse d'un tableau historique des progrès de l'esprit humain.

Probabilities Govern our Actions

by

LAPLACE

Almost all our knowledge is but probable; and in those few matters of which we can have certain knowledge, even in the mathematical sciences, induction and analogy—which are the principal methods of arriving at the truth—are based on probabilities, so that the entire system of human knowledge is bound up with the theory set forth in this essay. . .

A mind that, at a given moment, knew all the forces by which Nature is animated, and the respective situations of all the beings of which it is composed, supposing it were vast enough to submit these facts to analysis, could embrace in one single formula the movements of the largest bodies of the universe and those of the lightest atom: nothing would remain uncertain to it, and the future, like the past, would lie open before it. The degree of perfection which the human mind has been able to give to astronomy offers some slight notion of such an intellect. Its discoveries in mechanics and in geometry, together with those of universal gravity, have enabled it to comprehend in the same analytical formulae the past and future states of the system of the world. By applying the same method to some other subjects of its knowledge, it has succeeded in reducing to general laws observed phenomena, and in foreseeing those which must arise from certain given circumstances. All its efforts in the search for truth tend to bring it continually closer to the intellect we have just conceived, from which, however, it must always remain infinitely remote. It is this tendency, peculiar to the human species, which raises it above the animals, and the progress achieved in this domain marks out nations and centuries, and constitutes their true glory. . .

One of the most important points in the Theory of Probability, and that which gives most rise to

illusions, is the manner in which probabilities increase or diminish through their various combinations. . . . Let us suppose that a fact has been related to us through the medium of 20 witnesses, the first of whom has related it to the second, the second to the third, and so on; let us further suppose that the degree of probability of each relation is 9/10; that of the fact resulting from all the evidence will thus be less than 1/8. This diminution of probability can best be compared to the loss of clearness of objects by the interposition of several pieces of glass, a small number of pieces being sufficient to conceal an object which can be clearly perceived through one single piece. Historians do not appear to have paid enough attention to this diminution in the probability of facts when seen across many successive generations; several historical events, taken as certainties, would be doubtful, to say the least, if tested by this method.

In the purely mathematical sciences, the most distant consequences share the certainty of the principle from which they derive. In the application of analysis to physics, the consequences have all the certainty of facts or experiences. But in the moral sciences, where each consequence is drawn from that which precedes it solely in the light of probability, however probable these deductions may be, the likelihood of error increases in proportion to their number, and finally, in those consequences which are far distant from their principle, outstrips the likelihood of truth. . .

Thus, the action of time continually weakens the probability of historical facts, just as it wears away the most enduring monuments. We can, it is true, slow down this action by multiplying and preserving the evidence and the monuments which support it. Printing, which unfortunately was not known to the ancients, is a great means to this end. But despite the innumerable advantages it offers, the physical and moral revolutions by which the world will always be shaken must eventually, after thousands of years and in association with the inevitable effect of time, shed doubt on the historical facts which today seem the most certain. . .

Whenever a great power, impelled by love of conquest, aspires to world-wide dominion, the desire to preserve their independence unites the threatened nations in a coalition which is almost always fatal to the aggressor. Similarly, amid the variable causes which determine the expansion or contraction of the different States, natural frontiers, acting as invariable causes, must in the end prevail. It is therefore in the interest both of the stability and of the happiness of an empire that they should not be extended beyond those limits within which they are continually driven back by the action of these causes, as the waters of the sea, whipped up by a violent tempest, fall again, by the force of gravity, into their natural hollows. This is another effect of the Theory of Probability, which has been proved by frequent and dire experience. History, regarded from the standpoint of the influence of invariable causes, would couple with the interest of curiosity that of offering the most valuable lessons to mankind. The inevitable effects of these causes are sometimes attributed to accidental circumstances which have merely extended their action. It is, for instance, contrary to the natural order of things that a people should be permanently governed by another which is separated from it by a wide sea or a great distance. It can be confidently asserted that in the long run this invariable cause, continually adding its effect to the variable causes that work in the same direction and are strengthened by the passage of time, will give rise to causes strong enough to restore the subjugated people to its natural independence, or to unite it to some powerful neighbouring State. . .

Human institutions are affected by so many causes which are unexpected, concealed or impossible to estimate, that their results cannot be judged *a priori*. The series of events that time unfolds brings these results to maturity and suggests means of remedying such of them as are harmful. Wise laws have often been made for this purpose; but because the reason for them had not been properly recorded, several of them have been repealed as useless, and have been revived only after unfortunate experiences have again shown them to be necessary. It is therefore very important that every branch of public administration should keep a precise record of the effects produced by the various methods adopted, which are in the nature of large-scale experiments made by the governments concerned. We should apply to the political and moral sciences that method, based on observation and calculation, which has served us so well in the natural sciences. Whilst refraining from a useless and often dangerous resistance to the inevitable effects of advances in knowledge, we should proceed with the utmost caution when making changes in our institutions and in the customs to which we have adhered for so long. From past experience we are well aware of their drawbacks; but we do not know the extent of the evils that any alteration of them may bring about. In that ignorance, the Theory of Probability counsels us to avoid any change; especially sudden changes which, on the moral and the physical plane alike, can never take place without a great loss of energy. . .

Analysis confirms the conclusion to which we are led by common sense—that is, that the more numerous and enlightened the judges, the sounder will be the judgments. It is therefore desirable that Courts of Appeal should fulfil these two conditions. Courts of first instance, being less remote from the litigants, offer them the advantage of a first verdict that is probable and with which they often show themselves satisfied, either by reaching a compromise or by abandoning their claims. But if the uncertainty of the matter in dispute, and its importance, determine a plaintiff to have recourse to the Court of Appeal, then the greater probability of obtaining a fair verdict should assure him of greater security for his fortune and compensate him for the trouble and expense involved in such further proceedings.

This was by no means the case with the institution of the reciprocal appeal in departmental courts, an institution which for that reason was very detrimental to the interests of citizens. It would perhaps be suitable, and in accordance with the Theory of Probability, if a majority of at least two votes were required in a Court of Appeal to reverse the verdict of a lower court. This result would be obtained if, where the Court of Appeal consists of an even number of judges, that verdict were maintained in cases where the votes were equally divided.

I will now turn more particularly to the verdicts in criminal cases.

It is true that, before condemning an accused man, the judges require the strongest proof of his guilt. But moral proof is never more than a probability, and experience has shown only too clearly that the verdict in a criminal case may be mistaken, even when it appears exceptionally well founded. The possibility of correcting such errors is the strongest argument put forward by those philosophers who have been in favour of abolishing the death penalty. If we had to wait for mathematical proof, we should be obliged to abstain from judging. But judgment is a necessity, owing to the dangerous situation which would arise if crime went unpunished. Any judgment, if I am not mistaken, seeks to answer the following question. Has the crime of the accused been proved with such a high degree of probability that citizens will have less to fear from the errors of the courts, if he is innocent yet condemned, than from his further misdeeds and those of the wretches whom the example of his impunity would embolden, if he were guilty yet acquitted? The answer to this question depends upon several factors which are very hard to ascertain. One of these is the imminence of the danger which would threaten society if the accused criminal went unpunished. This danger is sometimes so great that the magistrate feels obliged to depart from the procedure wisely laid down for the protection of the innocent. But what almost always renders the problem insoluble is the impossibility of assessing the exact probability of the crime, and of laying down the degree of probability necessary for the condemnation of the accused. In this matter, every judge has to rely on his own discretion. He forms his opinion through a comparison of the various testimonies and the circumstances of the crime, combined with the results of his own reflexions and experience, and here a long familiarity with the questioning and judging of accused persons is of great advantage in singling out the truth from among evidence that is often contradictory.

The foregoing question is affected, also, by the magnitude of the penalty attaching to the crime, for if a death-sentence is to be passed, much stronger proof will naturally be required than if the matter is one for a few months' imprisonment. This is a reason for making the punishment fit the crime, since a heavy penalty attaching to a slight offence will inevitably lead to the acquittal of many offenders. The danger to society represented by the acquittal of the accused may be expressed mathematically by multiplying the probability of the crime by its gravity; it may therefore be considered that the penalty should be in relation to this probability. This is indirectly ensured in the courts, where an accused person, of whose guilt there is very strong evidence but insufficient to lead to a condemnation, is kept in custody for a certain period; in the hope that further light may be shed on the case he is not restored forthwith to the company of his fellow-citizens, to whom his reappearance would be a cause of considerable alarm. But the arbitrary nature of this measure, and the abuses to which it can give rise, have caused it to be abolished in those countries where the greatest value is set upon personal liberty.

Now, what is the probability that the decision of a court, which can give only a majority verdict, will be just, that is to say, will correspond to the correct solution of the problem just set forth? A satisfactory solution to this important problem would provide a means of comparison between the various courts A majority of only one vote in a large tribunal indicates that the case in question is very doubtful; to pass sentence would thus be contrary to those humane principles which protect the innocent. Unanimity among the judges gives a very strong probability of a correct verdict, but if it were to be insisted upon, too many of the guilty would be acquitted. It is therefore necessary either to limit the number of judges if they are to be unanimous, or, in the case of a larger tribunal, raise the majority required for a condemnation. I will now attempt to apply the calculus to this subject, being convinced that when based on the promptings of common sense it is always the surest guide.

The principal factor in this calculus is the probability that every judge will form a correct opinion. This probability obviously varies with each case. It is evident that if, in a court consisting of 1,001 judges, 501 hold one opinion while the remaining 500 hold the contrary opinion, there is scarcely more than half a probability for any one judge's opinion; for were the probability appreciably greater, it cannot be supposed that there would be so small a majority as one vote. But unanimity among the judges would indicate a body of proof so strong as to carry conviction; the probability of each judge's opinion is in this case very near to the unit, in other words to certainty, unless all the judges are simultaneously swayed by common passions or prejudices. Apart from such instances, the degree of probability can only be determined by the ratio of votes cast for and against the accused. I will therefore assume that it can range from 1/2 to the unit, but cannot fall below 1/2. Otherwise, the court's decision would have no more weight than a casting of lots; its sole value resides in the likelihood that the judge's opinion tends to be correct rather than erroneous. I then assess the probability of this opinion by examining the ratio of favourable to unfavourable votes.

These factors suffice for a general expression of the probability that the decision of a court,

rendered by means of a given majority, will be correct. In courts with eight judges where five votes are required to secure a condemnation, the probability of error in the decision would amount to more than 1/4. If the court were reduced to six judges and four votes were required to secure a conviction, the probability of error would be less than 1/4; such a reduction in the size of the court would therefore be in the interest of the accused. In either case the majority required is the same, i.e. two votes. Hence, as this majority remains constant, the probability of error increases with the number of judges; this is general, whatever be the majority required, so long as it remains unchanged. Taking therefore arithmetical ratio as the rule, the position of the accused becomes more and more unfavourable as the number of judges is increased. It might be supposed that in a court where a majority of 12 is required, whatever the number of judges, since the minority votes would cancel out a corresponding number of votes on the side of the majority, the 12 remaining votes would be equivalent to unanimity in a jury of 12 members, such as is necessary in England for the conviction of an accused person. But this would be a great mistake. Common sense points out that there is a difference between the decision of a court of 212 judges, 112 of whom convict the accused while 100 acquit him, and that of a court of 12 judges who are unanimously in favour of condemnation. In the former case, the 100 votes cast for the accused entitle us to suppose that the proofs are by no means so strong as to be convincing; in the second case, the unanimity of the judges suggests that the proofs are sufficiently strong. But common sense alone cannot suffice to estimate the extreme difference in the probability of error in the two cases. We must again resort to the calculus, which shows that the probability of error in the former case is about 1/5, whereas in the latter case it is only 1/8192, or less than 1/1000 of the former. This confirms the principle that arithmetical ratio is unfavourable to the accused when the number of judges is increased. If, on the contrary, geometrical ratio is taken as a basis, the probability of an erroneous decision diminishes as the number of judges is increased. For instance, in courts where a 2/3 majority is required for a conviction, the probability of error is about 1/4 if there are six judges; it falls to less than 1/7 if the number of judges is increased to 12. Therefore, to ensure that the probability of error will never fall below or rise above a given fraction, neither arithmetical nor geometrical ratio can be taken as a basis.

But what fraction should be decided upon? Here begins the domain of the arbitrary, and there is much variation among the courts in this respect. In special courts, where five votes out of eight are sufficient to secure a conviction, the probability of an erroneous verdict is 65/256, or more than 1/4. This proportion is alarmingly high, but some reassurance may be drawn from the fact that in most cases the judge who acquits an accused person does not regard him as innocent, but merely declares the case against him to be not proven. Most reassuring of all is that pity which nature has placed in the heart of man, and which makes the mind reluctant to see a guilty man in the accused brought before its judgment. This feeling, stronger in those who are unaccustomed to criminal trials, offsets the drawbacks that arise from the inexperience of jurors. In a jury of 12, where eight votes out of 12 are required to secure a verdict, the probability of error is 1093/8192, or rather more than 1/8; if the number of votes required is nine, the probability of error is about 1/22. In the case of unanimity, the probability of error is 1/8192, or less than 1/1000 of that which exists in our juries. This is on the assumption that unanimity results solely from the body of evidence favourable or unfavourable to the accused; but when unanimity is demanded of a jury as a necessary condition of the verdict, entirely different motives must often contribute to produce it. Consequently, as these decisions depend on the temperament, character and habits of the jurors, they are sometimes contrary to decisions which the majority of the jury would have taken in the light of the evidence alone, and this appears to me to be a great defect of this method of trial.

The probability of correct decision is too slight in our juries, and my opinion is that in the interests of the innocent, at least nine votes out of 12 should be required. . .

Our passions, our prejudices, and prevailing opinion, by exaggerating those probabilities which are favourable to them and glossing over those which are unfavourable, give rise to an abundance of dangerous illusions.

Present evils, and the cause from which they originate, affect us far more powerfully than does recollection of the evils produced by the contrary cause; they prevent us from appreciating rightly the disadvantages of the one and the other, and the probable success of methods of preserving ourselves from both. This is why a nation which is shaken out of a period of calm will alternately swing over to despotism and anarchy, recovering its tranquillity only after a long and cruel period of unrest.

The vivid impression made upon us by present events, which leaves us almost unconscious of contrary events noticed by others, is a main cause of error, which we cannot too carefully guard against.

It is principally in gambling that innumerable illusions feed hope and uphold it in the face of ill-luck. Few purchasers of lottery-tickets know how many chances are against them and how many in their favour. They think only of the possibility of winning a considerable sum in return for a small outlay, and the schemes built up by their imagination strengthen, in their view, the probability of success. The poor man more especially, urged on by the desire to better his circumstances, risks what he cannot afford to lose, pursuing the most unfavourable systems which hold out hopes of large profits. If all these people were to learn how vast is the number of lost stakes, they would doubtless be appalled; but care is taken, on the

contrary, to give great publicity to the winning tickets, which acts as a further incitement to this pernicious gamble. . .

The estimation of probabilities is attended by a type of illusion which, since it results in a special manner from the laws of intellectual organization, can be avoided only by a thorough study of those laws. The wish to look into the future, and the way in which certain remarkable events have coincided with the predictions of astrologers, soothsayers and fortune-tellers, together with presentiments and dreams, with numbers or days reputed to be lucky or unlucky, have given rise to a swarm of prejudices that are still very widespread. No one thinks about the great number of occasions when no coincidence has occurred, since these have made no impression, or are unknown. They must, however, be known, before it can be possible to assess the probability of the causes to which the coincidences are attributed. Such knowledge would no doubt confirm what reason tells us concerning these prejudices. Thus, the philosopher of old, on being shown in a temple, as proof of the power of its tutelary deity, the votive offerings of those who, calling upon his name, had escaped from shipwreck, was speaking in accordance with the Theory of Probability when he observed that he did not perceive there the names of those who, despite their prayers, had perished.

Extracts from Essai philosophique sur les probabilités.

Towards a Scientific and Industrial Society

by

HENRI DE SAINT-SIMON

Such is the difference between the old order of things and the new, between the order of 50, 40, or even 30 years ago and that of today that, in those still very recent times, the test of a man's education was the question: "Is he conversant with his Greek and Latin authors?," while today it is: "Is he strong in mathematics? Is he master of the knowledge acquired in physics, chemistry and natural history—in a word, in the positive sciences and those of observation?"

Extract from the Mémoire sur la science de l'homme *(1813).*

What are the general sources of happiness for society? We do not hesitate to declare, and every sensible person will find this to be true, that they are none other than the sciences, the fine arts, and the arts and crafts; for the happiness of man depends upon the satisfaction of his physical and moral needs, and this is the sole aim and the more or less immediate object of the sciences, fine arts and arts and crafts. All activities really useful to society fall within these three domains and only within these three; outside them there are but parasites and tyrants. All that has been done until now, and all that can ever be done for the happiness of men, can serve for the improvement of their lot only in so far as it tends, directly or indirectly, to apply, propagate or perfect the knowledge acquired in the sciences, the fine arts and in the arts and crafts. It cannot be too often repeated that the only useful action exercised by man is that which he wields over material things. The action of man on man is always, in itself, harmful to mankind because of the double expenditure of force involved; it is profitable only so far as it is accessory, contributing to the exertion of a greater action upon nature.

Far be it from us to contend that, *in the present state of things*, there are no useful men save scientists, artists and craftsmen, nor useful work save theirs. For, as society is yet constituted, these three classes are dominated by parasites; and all who, though not belonging to any of the three, try to liberate them from that domination perform a function that is not only most useful, but absolutely indispensable. Their influence, though indirect, is unquestionably beneficial to the sciences, the fine arts and the arts and crafts But who can fail to see that this is, as it were, a temporary expedient and must cease with the removal of the state of affairs—necessarily temporary—that occasions it? Moreover, society cannot be organized on a critical basis and, since our present aim is to find a principle on which a new social system can be established, we must disregard everything that is of a transitional nature.

Thus, it seems, we may lay down the principle that, in the new political order, the single and permanent aim of social organization should be

the best possible application of the knowledge acquired in the sciences, the fine arts and the arts and crafts to the satisfaction of the needs of man; the propagation, perfecting and increase of such knowledge on the greatest possible scale; in a word, the most fruitful concert of all separate efforts in the sciences, the fine arts and the arts and crafts.

This is not the place to describe in detail the astonishing degree of prosperity to which society organized on such lines might attain; it can be easily imagined. . .

In a society organized for the positive end of achieving prosperity through the sciences, the fine arts and the arts and crafts, the most important political function—which is to determine the direction in which the society shall advance—is no longer the prerogative of the men in whom the offices of society are vested, but is exercised by the body of society itself. It is in this way that society, regarded as a collective unit, can really exercise sovereignty—a sovereignty consisting then no longer in an arbitrary opinion given force of law by the mass, but in a principle derived from the very nature of things, whose soundness and necessity men simply recognize and proclaim. In such an order the citizens holding the various offices of society, even the most exalted, from a certain point of view, play a subordinate part; since their functions, however important, lie only in pursuing a direction which they themselves have not chosen. Moreover, the aim and object of a society so organized are so clear and definite that there is no longer room for the arbitrary will of man or even of the law, for neither can find exercise save where there is lack of precision—this being, as it were, their natural element. The action of government, in the sense of direction or command, is then void, or practically so. All the questions which must exercise men's minds in such a political system—what enterprises will enable society to increase its present prosperity with the help of the knowledge it has acquired in the sciences, the fine arts and the arts and crafts? What steps should be taken to spread this knowledge and, so far as possible, perfect it? How, lastly, can these various enterprises be carried out with the minimum expenditure of money and time?—all these questions, we would say, and all others arising out of them, are eminently positive and accessible to judgment. The decisions taken in regard to them can be the outcome only of scientific demonstration, completely independent of man's will and susceptible of discussion by all who are equipped by education to comprehend it. Since, moreover, in such a society all social functions are of a positive nature and have a clearly defined aim, the capacities required for their discharge are so clear and so easily identifiable that there can never be any doubt on this point, and each citizen will naturally tend to confine himself to the role fort which he is most apt. And, just as all questions of social import will necessarily be decided as well as possible in the light of the contemporary body of knowledge, so will all social functions necessarily be entrusted to the men who are most capable of performing them in conformity with the general aim of the association Thus, in this new order, the three main defects of the present political system—arbitrariness, incompetency and intrigue—will disappear.

If, in our brief statement of the aim henceforth to be pursued in the organization of society, we have made no mention of the maintenance of public order, it is because the maintenance of public order, though truly an essential condition for any enterprise by society, cannot be regarded as the aim of society. The view—conceived and given credence by some very worthy men—that the sole and exclusive object of the political system should be to maintain order is based on the fact that, in the present state of affairs, the only real purpose served by governments is in fact to ensure, with more or less success, that all citizens may work in tranquillity and security. It has been recognized that almost all the measures which governments have taken with the professed object of advancing social prosperity have had no effective result save to hinder it; and in consequence it has become an adage that the best contribution governments can make to the happiness of society is to refrain from meddling in it. But this view, though sound when considered simply in relation to the existing political system, is clearly false when conceived in the absolute; it can thus survive only so long as we fail to rise to the idea of a different political system.

In the new organization of society, therefore, the functions specifically connected with the maintenance of public order will be given their natural and proper place as subordinate, police functions, for it is obvious that they can be major functions only so long as the association has no aim; the moment that it has an aim of any sort, even if it be a wicked one, they become secondary. Now, we may observe that this part of social action will, in the new order, be the only one necessitating a certain degree of command exercised by men over men, since all remaining activities, as we have explained, will be determined by principles. Consequently, the action of government, properly speaking, will be as limited as possible. Men will thus enjoy, in that order of things, the highest degree of liberty compatible with the state of society. It is indeed to be noted that this function of maintaining public order may very well devolve, almost entirely, upon the whole body of citizens, either for the restraint of those who would disturb the peace or for the settlement of disputes. Thus an extremely small measure of power accorded to the men specially responsible for this function will suffice, and will be all the less dangerous to liberty in that such men will be classified only as subordinates. When the political system is not clearly directed towards social prosperity, a very large machine of government is needed to maintain public order, for in such a case the mass of the people must needs be regarded as the enemies of the established order. But when each citizen clearly sees the goal of betterment towards which the community is progressing, and the successive steps in the advance,

the mass of the people acts as a passive force which is almost sufficient of itself to restrain an anti-social minority.

We suppose that France suddenly loses her 50 leading physicists, her 50 leading chemists, her 50 leading physiologists, her 50 leading mathematicians, her 50 leading poets, her 50 leading painters, her 50 leading sculptors, her 50 leading musicians, her 50 leading men of letters; her 50 leading mechanics, her 50 leading engineers—civil and military—her 50 leading artillerymen, her 50 leading architects, her 50 leading doctors, her 50 leading surgeons, her 50 leading pharmacists, her 50 leading sailors, her 50 leading watchmakers; her 50 leading bankers ; her 200 leading merchants, her 600 leading agriculturalists, her 50 leading ironmasters, her 50 leading arms-manufacturers, her 50 leading tanners, her 50 leading dyers ; her 50 leading miners; her 50 leading cloth-manufacturers, her 50 leading cotton-manufacturers, her 50 leading silk-manufacturers, her 50 leading linen-manufacturers, her 50 leading hardware-manufacturers, her 50 leading earthenware, and porcelain—manufacturers, her 50 leading, crystal and glass—manufacturers, her 50 leading shipowners, her 50 leading haulage contractors; her 50 leading printers, her 50 leading engravers, her 50 leading goldsmiths and other metal-workers; her 50 leading masons, her 50 leading carpenters, her 50 leading joiners, her 50 leading farriers, her 50 leading locksmiths, her 50 leading cutlers, her 50 leading smelters; and 100 other persons exercising other callings among those most highly-skilled in the sciences, the fine arts and the arts and crafts—amounting in all to the 3,000 leading scientists, artists and artisans in the country.[1]

As these men are the most essential producers of France, those who provide the most important commodities, those who direct the work most useful to the nation and render it productive in the sciences, the fine arts and the arts and crafts, they are the very flower of French society; they are, of all Frenchmen, those most useful to their country, those who bring most glory and do most to advance its civilization and increase its prosperity. The nation would become a body without a soul in the moment of their loss; it would immediately sink to a position of inferiority in relation to nations which today it can rival, and would remain in that state of inferiority until it had repaired the loss and, as it were, grown another head. France would need a whole generation at least to repair this disaster, for those men who distinguish themselves in activities which are of positive use to society are veritable anomalies; and nature is not prodigal of her anomalies, particularly those of this sort.

Let us pass to another assumption. Let us assume that France keeps all her men of genius in the sciences, the fine arts and the arts and crafts, but has the misfortune to lose, on the same day, Monsieur, the Brother of the King, H.R.H. the Duke of Angoulême, H.R.H. the Duke of Orleans, H.R.H. the Duke of Bourbon, H.R.H. the Duchess of Angoulême, H.R.H. the Duchess of Berry, H.R.H. the Duchess of Orleans, H.R.H. the Duchess of Bourbon and Mademoiselle de Condé.

That she loses, at the same moment, all the great Officers of the Crown, all the Ministers of State (with or without portfolio), all the Councillors of State, all the *Maîtres des Requêtes*, all her marshals, all her cardinals, archbishops, bishops, vicars-general and canons, all the prefects and subprefects, all those employed in her Ministries, all the judges, and, in addition, the 10,000 wealthiest proprietors among those who live nobly.

This accident would certainly grieve the French people, for they are kind-hearted and could not witness, unmoved, the sudden disappearance of so large a number of their fellow-countrymen. But the grief caused by this loss of some 30,000 individuals, reputed as the most important citizens of the State, would be purely sentimental, for there would result no political evil to the State. . .

The prosperity of France can be secured only as the effect and result of the progress of the sciences, the fine arts and the arts and crafts; but the princes, the great officers of the Crown, the bishops, marshals of France, prefects and idle landowners do not directly contribute to the progress of the sciences, the fine arts and the arts and crafts; on the contrary, they can only hamper such progress, since they seek to prolong the preponderating influence hitherto brought to bear by conjectural theories on positive knowledge. They inevitably prejudice the prosperity of the nation by depriving, as they do, scientists, artists and artisans of that priority in esteem which is their legitimate due; by using their financial resources in ways that are not directly useful to the sciences, the fine arts and the arts and crafts; by appropriating for themselves, each year, out of the taxes paid by the nation, a sum of three or four hundred millions in respect of salaries, pensions, gratuities, allowances, and so forth in payment for their work, which is of no use to the nation.

Extracts from L'organisateur *(1819).*

The basis of the new system will be work whereby the desires common to all French citizens, and the means to be employed in order to satisfy those desires, will be clearly expressed.

I shall now, dear countrymen, give you an outline of the main ideas which will determine this work.

First of all, it is obvious that the intent of all French citizens is to improve their material and moral conditions of life.

We must, therefore, make quite clear what we mean by the material and moral happiness of a nation

You will agree that the country in which the people are best fed, best housed and best clothed, in which they can travel most easily and procure the necessities and amenities of life wherever they

[1] The term "artisans" is generally applied only to ordinary workmen. In order to avoid circumlocution, we use the term to describe all persons concerned with the production of material things: agriculturalists, manufacturers, merchants and bankers, and all the clerks and workpeople they employ.

go, is the country where they are happiest from the material point of view.

You will also agree that if, in this same country, the intellect of men is developed, if they are able to appreciate the fine arts, and are familiar with the laws which govern natural phenomena and the methods of modifying them, and if they are well-disposed one towards another, they will enjoy the greatest possible measure of happiness from the moral point of view.

Let us now consider by what means the double advantage of material and moral happiness may be secured for the French people.

In order to achieve material happiness, it is necessary that agriculture, manufactures and trade be encouraged and fostered to the maximum. The inducement of special advantages must be offered with a view to stimulating all enterprises for the construction of canals, roads and bridges, and for drainage work, land clearing and irrigation. We should not haggle over the profits which accrue from works of public utility, but willingly concede them to the private quarters undertaking such works.

With regard to the moral happiness of the nation, we must entrust the education of the young, and of the people in general, to those scholars and scientists whose knowledge is of most positive value.

Extracts from the pamphlet Des Bourbons et des Stuarts *(1822).*

Those who paved the way for the Revolution, those who directed it, and all those who, from 1789 to the present day, have guided the nation, have been guilty of a grave political error; they have all sought to improve governmental activity, whereas they should have subordinated it, and made administrative activity supreme.

They should have begun by asking themselves a question whose solution is very simple and easy to find.

They should have asked themselves: Who, in the present state of customs and of enlightenment, are the men most capable of directing the national interests aright?

They would have been forced to admit that those who possess the greatest and widest capacities, which are therefore of most positive value in the guidance of contemporary minds, are the scientists, artists and leaders of industry. They would have recognized that it is the work of the scientists, artists and industrialists which, as regards both invention and execution, makes the greatest contribution to the prosperity of the nation.

They would have concluded that it was to the scientists, artists and leaders of industry that administrative power, that is to say, the task of directing the national interests, should be confided; and that the functions of government should be restricted to the maintenance of public tranquillity.

Extracts from De l'organisation sociale *(1825).*

Some Remarks on Progress

by

PAUL VALÉRY

Artists of former times had little liking for what was called progress. They saw little more progress in creative works than the philosophers did in morals. They condemned the barbarous deeds of knowledge, the engineer's brutal treatment of the landscape, the tyranny of mechanization, the over-simplification of human types which compensates for the complications of collective organizations. Even as early as about 1840 people were protesting against the first effects of a transformation of society that was then only beginning. The Romantics, though contemporaries of the Amperes and Faradays, tended to be ignorant of the sciences or to despise them, or else to make use only of their fantastic side. They sought a spiritual refuge in a medieval period of their own imagining, preferring alchemy to chemistry. They took pleasure only in legend and history, that is at the antipodes of physics. Shunning organized existence, they abandoned themselves to the life of the passions and the emotions, on which they built a culture (and even a comedy).

A great man of that period, however, displayed an intellectual conduct that involved a remarkable contradiction. Edgar Allan Poe, who was one of the first to condemn the new barbarism and the cult of the modern, was also the first writer to think of introducing into literature, fiction-writing and even poetry, that very spirit of analysis and careful

construction whose action and excesses he himself deplored.

In short, the idol of progress had its counterpart in the idol of the denunciation of progress—both of them platitudes. . .

As for us, we are at a loss to know what to think of the prodigious changes that are taking place around us, and even within us. New powers, new problems—never has the world been less sure of where it was going. . .

Musing on the antipathy of artists to progress, a few further ideas occurred to me which I here set down for what they are worth.

During the first half of the nineteenth century, the artist discovers and defines his antithesis—the *bourgeois*. The *bourgeois* is the counterpart of the Romantic. The qualities attributed to him are, incidentally, contradictory, since he is described both as the slave of routine and as the absurd sectarian of progress. The *bourgeois* likes solid achievement and believes in improvement. He is the incarnation of common sense and attachment to tangible reality—but he believes in the gradual and almost inevitable improvement of living conditions. The artist reserves for himself the realm of "dreams".

But time—or perhaps the demon of unexpected combinations, who draws from existing facts the most astonishing inferences, whereon he builds the future—has delighted in taking two diametrically opposite notions and confusing them admirably. We find that the wonderful and the positive have contracted an astonishing alliance, these two inveterate enemies having conspired to turn our lives into an unending series of transformations and surprises. It may be said that men are becoming accustomed to regarding all knowledge as transient, all stages of their activity and of their relations as provisional. Reality is no longer neatly finished off. Place, time and matter are subject to fluctuations formerly undreamt of. Harsh necessity gives birth to dreams; dreams become reality; commonsense, confounded time and again by happy experience, is no longer evoked save by ignorance. The value of everyday evidence has dwindled to nothing. General acceptance, formerly an invincible argument in support of an opinion, now exercises the opposite effect. *Beliefs that were held by everyone, always and everywhere, no longer count for very much.* As against the kind of certainty emanating from the consensus of opinion and experience of a large number of persons, we now have a body of objective facts, scientifically established and interpreted by a small group of experts. It may be that the value attached to general opinion (on which our social laws and customs are still based) arose from the satisfaction that most people feel at finding themselves in agreement with, and similar to, their fellows.

Finally, nearly all the fantasies man has ever woven, fantasies recurring again and again in all kinds of fables—flying, diving to the depths of the sea, conjuring up that which is absent, recording the spoken word, transporting it, detaching it from its epoch and its source—these and many other strange phenomena hitherto undreamt of have now emerged from the realm of impossibility. The fabulous has taken root in commerce. Thousands of people live by the manufacture of miracle-machines. But the artist has taken no part in this manufacture of miracles; it is the offspring of science and capital. The *bourgeois* has invested his money in fantasy, and is speculating on the rout of commonsense. . .

Louis XIV himself at the height of his power possessed not one hundredth part of the control over nature and the opportunities for amusement, self-improvement or experience of novel sensations now accessible to so many people living in relatively humble circumstances. I am not, it is true, including the delights of giving orders, of subjugating, intimidating, dazzling, condemning or absolving one's fellows, which are theatrical and divine pleasures. But I am thinking of the control over time, distance and speed; of freedom, and opportunity to enjoy all the world has to offer.

A man of today, if young, healthy and fairly well-to-do, can fly where he wishes, crossing the globe in a trice, and sleeping every night in a palace. A hundred different forms of life are his for the asking; an amorous adventure here, a touch of permanence there, a little of everything. With a little imagination, but not of the kind which probes too deeply, he can enjoy the best of everything, finding happiness at every turn. The lot of the mightiest monarch was not more enviable than that of this modern man, whose mere physical well-being is superior; he is better protected against heat or cold, his skin and his muscles are in better trim. A king who fell ill could get but little relief; twisting and turning in his feather bed, he had no hope of the swift solace, the escape into unconsciousness which the advance of chemistry has placed within the reach of even the humblest sufferer in modern times.

As regards opportunities for pleasure, protection against pain and boredom, and the means of satisfying every type of curiosity, many ordinary people are better off today than the most influential man in Europe 250 years ago.

If the great process of transformation through which we are passing continues, sweeping away the remnants of old customs and creating entirely different needs and modes of life, we shall soon find ourselves in a completely new age where men will no longer preserve any spiritual links with the past. To them, history will seem strange and well-nigh incomprehensible, for nothing in the new age will have its counterpart in the past, and nothing of the past will survive in the present. Everything in man that is not purely physiological will have changed, for our ambitions, our politics, our wars, our customs and our arts are all undergoing a process of very rapid transformation; they are becoming linked more and more closely with the positive sciences, and less and less closely, therefore, with the past. *New fact* is tending increasingly to usurp the position hitherto occupied by tradition and *historical fact.*

Even now a native of one of the new countries visiting Versailles can and indeed should regard those figures—with their huge dusty wigs and their embroidered garb, depicted in noble, arresting attitudes—in the same light as we regard the feather or skin-bedecked dummies in the Ethnographical Museum, representing the priests and chieftains of tribes long since extinct.

Thus one of the surest and cruellest effects of progress is to give death yet another sting—a sting, moreover, which becomes automatically sharper with the rapid evolution of customs and ideas. Not only must men perish; they must also lose their meaning, become almost figures of fun. They must take their place—even those of them who have borne the name of Racine or Bossuet—amongst that collection of grotesque, motley figures which both provoke our mirth and fill us with awe as they stand on exhibition in our museums, connected vaguely in our minds with specimens of the animal kingdom.

I tried at one time to form a positive idea of what we call *progress*. If all moral, political or aesthetic considerations are put aside, progress might, I thought, be said to lie in a rapid and very marked increase in the (mechanical) *power* available for man's use, and in the *accuracy* with which he can foresee the future. An amount of horse-power, a number of verifiable decimals—these are figures which undoubtedly have increased enormously during the past century. Think for a moment of the fuel being consumed every day in motors of all kinds; think of the rate at which the world's reserves are being exhausted. The streets of Paris work and vibrate like a factory. In the evening, the city is a blaze of light, innumerable lamps dazzle the eyes with a fantastic, almost sinful expenditure of power. Has not wastage become a public and permanent necessity? Imagine what a long-term analysis of these everyday excesses might reveal! May not some observer in the distant future, looking back on our phase of civilization, explain the Great War as a deadly, but direct and inevitable, consequence of the expansion of our power? The extent, duration, intensity and even the atrocity of that war were in proportion to our peace-time resources, industries, machinery supplies and surplus; and it necessarily exceeded previous wars in scale by the amount by which these factors had increased in the ensuing interval. The difference, however, was more than one of mere proportions. In the physical world, it is impossible to increase the size of anything without soon producing a change in its *quality;* it is only in pure geometry that "similar" figures exist. Similitude is practically non-existent except as a mental concept. The last war cannot be regarded merely as an enlargement on previous wars. The wars of the past came to an end long before the nations engaged were really exhausted. It is thus that a good chess-player will throw in his hand after losing a single piece. It was by a kind of *convention* that the drama was brought to an end, and the factor which decided the superiority of one side over the other was symbolic rather than actual. On the other hand we witnessed, a few years ago, a modern war pursued until both opponents were exhausted, both having thrown all their resources into the struggle. Even Joseph de Maistre's famous saying, that a battle is only lost because it is thought to be lost, has ceased to be true. Modern battles are *really* lost, because men, bread, gold, coal and petroleum are used up and exhausted not only by the armies, but within the countries concerned themselves.

Of all the progress made, none is more striking than that made in the sphere of light. A few years ago, light was only a visual phenomenon. It could exist, or not exist. It either radiated through space or it encountered a substance which might modify it to a greater or lesser extent, but which remained alien to it. And now we find that light has become the greatest enigma in the world. The speed of light expresses and delimits something which is an essential factor of the universe. Light is even thought to have weight. A study of light radiation gives the lie to all our previous theories of space being empty, and time absolute. It has certain mysterious sets of resemblances to matter, and differences from matter. Finally, this same light, formerly taken as the common symbol for full, distinct and absolute knowledge, is now involved in a sort of intellectual scandal. Together with matter, it is involved in the quarrel between the discontinuous and the continuous, probability and actual images, units and large numbers, analysis and synthesis, concealed reality and the intellect seeking for it—the quarrel, in short, between the unintelligible and the intelligible. Science could here meet its critical point. But we shall find a way out.

Extract from "Propos sur le progrès", in Regards sur le monde actuel, *Paris, Gallimard, 1945.*

Science and Civilization

by

F. Le Lionnais

The merit of science is to make known truths external to man. Not that man has no part in them. He does not invent these observations, laws and theorems, but he puts his imprint on them. In particular, he reveals himself in the tactics he adopts for working them out.

Genius is more than merely a fine ornament for its own delectation and that of an intellectual limit. Since it affords unique information on certain limits of knowledge of the human species, it becomes common property. A discovery which has not up to the present proved of any technical value is none the less essential in order to allow man to realize his own capabilities. Goldbach, in 1742, pronounced his now-famous hypothesis: that every even number can be split up into the sum of two primary numbers. This hypothesis, which raises one of the most abstruse problems of the theory of numbers, has never been proved. The nearest approach was that of the Soviet mathematician, Vinogradov, who in 1937 proved that any sufficiently large whole is the sum of at most three uneven primary numbers. The history of technical progress in the twentieth century has no need for this result; in the history of science, on the other hand, it is indispensable; Vinogradov's demonstration constitutes an almost superhuman effort to crack the hard kernel of truth.

Genius apart, man reveals himself through his ingenuity.

The physical sciences abound in traces of human ingenuity, never to be confused with the caricatures found in other domains. Supersonic rays have been put to intriguing, entirely unexpected uses. Lucas, and Bicard in France, and Debye and Sears in the United States, were using them in 1932 for diffracting light in liquids; whilst Szent-György and Szalay, in 1933, used them for decomposing starch into dextrine. Electro-chemistry uses a wide variety of electrodes: air, distilled water, liquids falling drop by drop, flames, and sparks. Heirovsky in 1922 combined the drop-electrode with variable-voltage electrolysis—this is the polarographic analysis which the modern laboratory is now unable to do without. Brditchka applied Heirovsky's method for diagnosing cancer; he showed that the polarograms produced by the blood differ characteristically according to whether the patient is healthy, or suffering from cancer of the tonsils, gums, stomach or palate.

Chemical analysis kept pace with physics. The introduction of micro-analysis (Pregl, 1912) made it possible to deal with samples of 2-4 mg; "drop-chemistry" makes a study of dropper-reactions. Chromatographic and ultra-centrifugation processes make it possible to carry out separations which 50 years ago would have been thought impossible. We cannot, in a few lines, give any idea of the ingenuity Lecas and Konovaloff displayed in order to probe the enigma of the azeotropic mixture; these "defined pseudo-compounds" are in reality alloys which distil in the same way as pure substances. Similarly, a high degree of perspicacity was needed to solve the mystery of amphoteric substances—hermaphrodite substances which behave like acids in relation to bases, and like bases in relation to acids. Astronomers striving to solve the riddle of the skies have nothing but a few feeble rays of light to work on; is it not inconceivable that they are able to deduce therefrom such a wealth of information? The first photometric measurements of the stars were made by Newcomb (1901). In 1920 we find Michelson and Peace using interferences for measuring the diameter of stars; while Struve, in 1925, is using Doppler-Fizeau effects for measuring their rotation. In the biological sciences, we cannot but admire the ingenuity which led Chain to the discovery of diffusion factors.

In the pursuit of truth, all methods serve; victory comes sometimes to an individual, sometimes to a team. Never has collective effort been responsible for so much scientific progress as during our own age; and this is only a beginning; future generations will no doubt attribute to our century the first, albeit faltering, attempts to take science out of the hands of the individual specialist.

To do justice to the authors of all the discoveries mentioned in this account would involve doubling its length; ideas and facts would be drowned in a sea of names. In biochemistry, the history of every hormone and every vitamin is associated with a whole galaxy of geniuses; the name of Butenandt, for example, would have to be repeated a score of times.

Nature yields more easily to attack by disciplined armies than to guerilla fighters—a fact borne out by the increased number of collective discoveries made simultaneously during the last few decades. Between 1932 and 1934, three independent teams worked out the idea of the electronic microscope: Davidson and Calbick, Kroll and Ruska, and Binche and his collaborators. Whenever possible, teams exchange information on their work and arrange for collaboration. It was thus that the process for splitting uranium was elaborated; the work begun by Irene Joliot-Curie and B. Savitch was continued first by Otto Hahn and Strassmann, then by F. Joliot and J. Thibaut, and finally by Frisch and Lise Meitner.

This type of collaboration can no longer be

confined to one country alone. G. Perrier (1923) and G. Ferrié (1926) have shown that radio can be used for the calculation of distances from various points on the globe. Since 1933, 72 observatories have been engaged in making the fullest and most accurate possible measurements of our planet; their work has already given the lie to the hypothesis of the drift of continents; and the discovery of radar will introduce an even greater degree of accuracy. It was as a result of 10 years of work, under the supervision of H. Spencer Jones, by 25 observatories in 14 different countries, using 32 telescopes, that the average distance from the earth to the sun was measured with a degree of accuracy hitherto unequalled.

The rationalization of research is accompanied by an increase in the number of research workers. The Asian peoples, who had been out of the running since the Renaissance, have now returned to the arena. They have already produced two Nobel prizewinners: Raman (1930) and Yukawa (1949). The scientific output of Japan is in all respects comparable to that of the Western nations. More than one Indian or Chinese scientist might have been cited in the foregoing pages.

SCIENCE AND THE MOULDING OF THOUGHT

The influence of science on human thought is no longer contested; some admit it with regret, others with delight. But no systematic investigation on the subject has yet been made.

The mental gymnastics of research work make not only for greater logic and mental accuracy, but for greater boldness as well. Science represents imagination as well as reason; it is the best school man has for teaching non-conformity; it gives wings to thought.

The twentieth century has remained true to this tradition born of a long series of successful revolutions. *"All that we have believed in, all that the finest amongst us have accepted and taught for centuries past and that seemed to us to have the transparent, sparkling quality of glass, has suddenly acquired the fragility of glass as well. The idol is shattered; but it is we ourselves who have shattered it by a voluntary and painful amputation undertaken in the name of truth."* So wrote Jacques Duclaux in 1949. No science is proof against preconceived ideas; all gain from a constant readiness to question accepted fact; dozens, nay hundreds of examples could be quoted to prove this. We shall confine ourselves to two, taken from the field of chemistry. Radicals are groups of atoms which scientists for a long time refused to regard as molecules. They were treated merely as written formulæ—invaluable ones, it is true—for describing reactions or functions. In 1901, Gomberg, by isolating diphenylmethyl, and keeping it in a free state for a very short time, exploded a theory then generally accepted as an absolute truth. Similarly, chemical inertia—which is an undisputed property of rare gases—tended to acquire the status of a sort of metaphysical absolute. Manley and Forcrand brought the question down to earth, the former by producing mercury heliates (1924), the second by producing hydrates of krypton and xenon (1925).

Brought to the fore once more by the quantum theory, the dispute between the supporters and opponents of determinism provides an even better illustration of the war science has to wage against mental sclerosis.

Lacking a sufficiently minute analysis of the interaction between the scientist on the one hand and Nature on the other, classical determinism implied a contradiction which, though negligible on the human scale, became very obvious when investigations reached the level of elementary corpuscles. People had been behaving as though they believed in the possibility of jumping over one's own shadow. This naïve belief was demolished by Heisenberg's uncertainty principle. Von Neumann even seems to have demonstrated the impossibility of reconciling quantum mechanics with classical determinism by the addition of specially selected parameters. At present the search for truth is being hampered, as always, by the passionate partisanship of those involved. May we suggest that the discussion be clarified?

Belief in determinism was not originally a scientific necessity, but a spiritual one—a fact easily forgotten by its most uncompromising supporters. Their thesis reveals, beneath all their claims to objectivity, a persistent streak of subjectivity. Determinism cannot be regarde *a priori* as anything more than a working hypothesis, which only experience can transform into a law. But the fact is that experience has repeatedly confirmed the theory of determinism, sometimes providing clear proof, sometimes encountering phenomena too complex for it to interpret, but never coming up against contrary facts. Despite anything its detractors may say, determinism is one of the least questionable of the fundamental factors of external reality.

Study of the reaction of matter to energy, and vice versa, has shown that there is a limit to the possibilities of physicists' investigation. Planck's quantum of action is the ultimate limit of *a posteriori* knowledge. Apriorists of all kinds may indulge freely in conjectures as to what goes on beyond this point; but they must never expect to be accompanied, in these adventures, by the physicists.

Such has been the part played by human subjectivity in the discovery of objective truths. Up to the twentieth century, the universe and the observer had always remained apart—incidentally without any ill effects. Our epoch can take the credit for initiating a study of micro-phenomena in which the behaviour of the experimenter forms part of the experiment—not that objective factors thereby become subjective, but merely that both are combined in an amalgam in the face of which science stops short. To go farther—to use a signal victory of reason as a pretext for indulging in irrational mysticism—would be to make a mockery of words. The history of the sciences abounds in abortive attempts such as these, doomed to failure from the very outset.

Of all the strongholds of prejudice, the most strongly defended is that of anthropomorphism; every advance of science makes a breach in its walls; every defeat of anthropomorphism is a victory for man.

Surely the zeal with which the study of the question of the "missing link" has been pursued is a little excessive? Is it not inspired, in some cases, by a more or less conscious desire to lift man out of the animal evolutionary cycle? Except for details, no scholar any longer really disputes the origins of our species, whatever his philosophical or religious convictions may be.

To say that "man is descended from the monkey" is erroneous. The meaning of the word "monkey" needs extending; or, more simply, we should use the word "primate" (which is not popular). Inaccuracies of this kind are frequent in popular scientific jargon; and while they should not be encouraged, they do not actually do any harm. People who will gaily write that π=3.1416, or that the French are a Latin race, suddenly become purists in speaking of the origins of man; they hope, by discussing terminological expressions, to cast doubt on the nature of what they denote. A few years ago, some American biologists tried to prove that man was descended not from the monkey but from . . . the shrew-mouse! This theory does not appear to be a really serious one. But it was certainly opposed, even before it had been submitted to impartial examination, by numbers of people who, having reluctantly resigned themselves to "being descended from monkeys", evidently thought that was concession enough.

Astrobiology by revealing the presence of life beyond the limits of this earth, and cybernetics by producing mechanisms approximating to the human brain, are arguments in favour of the human soul to the extent that they widen man's horizons. We readily agree with Gaston Bachelard when he says that *"the man who makes robots will never be a robot himself."*

All too many people imagine that this glorious process of de-humanizing nature involves robbing it of its poetry, although the parallel histories of science and art show clearly enough that this is not so. The brilliant blue of the sky has lost none of its fascination because J. Cabannes has analysed its colour, proving it to be due to the diffusion of the solar rays, not by particles of dust, but by molecules (1913). Because Gebhardt (1912) traced the iridescence of the butterfly's wings to interferences on fine striae, or Harvey (1924) measured the bioluminescence of the glow-worm, or Seybold analysed the shade of the undergrowth, has their charm been in any way diminished thereby?

Science, by changing our vision of the world and our conception of our relations with nature, becomes a process of "moral adjustment". Laying our old ideas on the operating table, it refashions them in the image of truth. Is there a limit to this reshaping process, or shall we continue until the human spirit itself is transformed? It is as yet too soon to say. If the answer is to be in the affirmative, the arguments would be found in mathematics and theoretical physics.

Revolutions in mathematics do not catch the attention of the public immediately. Those of the nineteenth century are not yet fully assimilated. In view of the existence of functions without differential coefficients, it will no longer be possible to resort with naïve confidence to the second principle of the Cartesian method; while theologians will have to take cognizance of quantities greater than infinity. The twentieth century has made no small contribution to this re-assessment, in the wake of the Theory of Groups As against the materialists and the formalists, the so-called intuitionist school (Brouwer, Heything, H. Weyl, etc.) denies that the principle of the Excluded Third can be applied to transfinite groups: beyond the finite, a proposition may be something other than true or false. In this connexion, we might also mention the paradox of Banach and Tarsky, which one can hardly attempt to explain to the uninitiated without being accused of playing a practical joke!

In physics, we have acquired greater insight into the nature of reality only at the complete sacrifice of certain elementary common sense notions. This has been yet another proof of the danger of confusing our mental assumptions with natural laws.

The conception of mesomeria is fairly characteristic of the new mental climate to which we are having to adapt ourselves. This term is used to indicate the arrangement of atoms in molecules, an arrangement that cannot be expressed in terms of our existing symbols and conceptions of space. A rough idea can be given by saying that it lies somewhere between the various structures conceivable to common sense; but it is a little like talking of a rectilinear polygon with a number of sides halfway between those of the triangle and those of the square! The "tunnel-effect" which unexpectedly penetrates the atomic potential walls, also smacks of the miraculous. And what grotesque things we find, behind the forbiddingly dry technical terms and formulae, when we come to the realm of fermions, where Fermi-Dirac statistics reign supreme! How difficult it is to abandon the idea of individuality, intoxicated as we are by our experience of ourselves and of the world around us!

Of all these uprooting processes, none is more devastating than the re-orientation of our idea of time, which forces us to eradicate superstitions from the very depths of our subconscious. The idea that time is no more—and no less—definite than oxygen, no more sacred than weight, no more mysterious than temperature; the realization that it is not the physical incarnation of some principle superior to the principles governing other phenomena—these are notions fraught with consequences. We had always lived in a state of unconscious worship of time—of "chronolatry". Who can tell what will happen to human behaviour when the ghost of this false divinity is exorcized?

The importance of images and of certain logical formulae is constantly decreasing, as that of mathematical formulae increases. We for our part do not regard this as an argument in favour of philosophical idealism. Models, erected by man on the basis of his own sensations and everyday

experience, lose their value progressively as we move farther away from our bases. We must resign ourselves to using ever more unfamiliar formulae, with all the inconveniences attendant on this mental asceticism. But the fact is that the thread connecting us with remote realities is growing longer as well as thinner, extending our knowledge and our powers accordingly. Those of the strands which split under the strain, and to which we used to attach so much importance, now turn out after all to have been the flimsiest; and the ones which still hold fast, for all their seeming frailty, have in fact a more solid structure. What happens is not that matter retreats in the face of mathematics, nor that nature dissolves into spirit; but that naïve intuition and common sense are routed by reason, reinforced by the weight of experience.

SCIENCE AND CIVILIZATION

The influence exercised by science on the material development of societies, through the introduction of technical processes, is self-evident. Brief study suffices to show that it is artificial to separate the two. Any advance in knowledge eventually leads to practical application, and vice versa.

Many of the discoveries of the twentieth century have not yet been applied in practice, and people tend to be sceptical about causes, the effects of which they have not yet felt. A decisive step towards solving the problem of feeding the human race will have been taken when we discover how to make a synthesis of chlorophyll. What a transformation that will be in the history of civilization! And if future generations, playing with the elasticity of time, establish the science of chronotechnics, then the present half-century will have had the privilege of launching—almost unconsciously—an invention more momentous than the discovery of fire, the wheel, the printing-press or electricity! And suppose that man, controlling mutations, decided to create a race of supermen? It is a dizzy prospect indeed.

Thus science—either directly, by transforming our habits of thought, or indirectly, through new techniques—is the great fashioner of societies; it is on her anvil that our customs, our arts, our very fate are forged.

Those detractors of science who uphold art as an opposing force are the victims of a gross misconception. If we reject Archimedes, Galileo or Maxwell, we shall have to reject Giotto, Mozart or Rimbaud as well. Who can foresee the repercussions of the present half-century of scientific activity on the pattern of our everyday life, our leisure pursuits, the expansion of our intelligence, philosophical beliefs and feelings, the transfiguration of music, painting and poetry? Do we not seem to be approaching the "wonderland" so charmingly revealed to us in our childhood by a little girl, whose father was a mathematician?

Yet the whispers we hear of the future are not whispers of joy and hope. *"All scientists are afraid"*, writes Urey, the expert on heavy water. And what of the ordinary man? A survival of primitive terrors, the age-old dread of science still reigns in the hearts of the denizens of our modern cities, engendering an attitude of dispirited resignation in the face of change.

Are these fears vain? Certainly not. But what is vain is to imagine that lamentations can in any way affect the relentless advance of an artillery shell; to see defeat as the only outcome of the struggle; to be afraid of action and the unknown; to retreat instead of deploying our forces. We should pity our modern Jeremiahs and call on them to lift up their heads; the first victims of a battle are those who flee.

Science, man's creature, is now challenging its master to adventure. We must respond with enthusiasm, courage and intelligence.

Extracts from "Les sciences", in Cinquante années de découvertes, *Paris, Editions du Seuil, 1950.*

The Future of Biology

by

JEAN ROSTAND

Anatole France said, in about 1890, that "there is no such thing as biology. When the science of biology is established, that is to say in a few thousand years' time. . . ." Yet it is no exaggeration to say that a science of life does, today, exist.

This recent branch of learning whose origins

are lost in the distant past, long remained in a sort of childhood state in which it was kept both by philosophic prejudice and experimental difficulties. It can now however be said to have reached its majority, and its development has been so rapid that on many points it now competes, in accuracy and efficiency, with its elders, the sciences dealing with raw matter.

Biology plays an important part in our society, and will continue increasingly to do so. It is hardly necessary to recall the extraordinary advances that medicine and surgery owe to it. A host of diseases which used to be considered incurable are now successfully fought by the use of hormones, vaccines, serums, and antibiotic substances (such as sulfa drugs, penicillin, streptomycine), by blood transfusions, and by ever more daring operation techniques. Thus there has been a notable extension of the length of human life in every civilized country, while the number of individuals who, on reaching maturity, can give the community the benefit of their personal experience, is also constantly increasing; and this result of civilization is an important factor of civilization itself.

It is not, however, the sole object of biology to provide medical science with a wealth of therapeutic resources. It aims not only at overcoming morbid deficiencies, at normalizing the abnormal, but at improving the normal, at going beyond simply maintaining health, by endowing all the representatives of the human species with the physical and intellectual qualities that nature has conferred only on a privileged *élite*. Since centenarians exist, why should it not be made possible for all human beings to live for a hundred years? Since men of genius exist, why should it not be made possible for all human beings to excel in mental ability?

Biology can even claim to surpass nature and to produce human individuals superior to any that have yet been born. It cherishes many other ambitions as well; since it has resolved to intervene in our ways of childbearing and of existing in general, it is preparing to change our whole way of life, and influence our habits, if not indeed our hearts.

Voluntary determination of sex, the generating of children without the aid of a father, test-tube babies, and so forth—all this is already seriously contemplated and even promised by biologists, although they do not commit themselves as to the date at which it is to come about.

There can be no doubt that, from now on, humanity will be able to control, to a great extent, its own organic destiny. It need not be objected that we do not know enough about heredity to act decisively on man. If humanity were to find itself in the hands of a superior being who knew no more than itself about genetics, but in whose interest it would be to make it evolve, it would soon be making perceptible progress.

Today therefore the question is one not of knowing and being able, but of desiring and daring.... Encouraged by our successes in zootechnics and phytotechnics, are we to go forward courageously to anthropotechnics? Are we prepared to submit ourselves to those same techniques that are so astonishingly successful when applied to our livestock and our poultry?

There lies the whole problem. It is a *purely moral problem*—one that it is not for scientists alone to resolve.

Positive, even more than negative, eugenics bring us up against immense difficulties, social as well as individual. They encounter strong affective resistance, which is hard to overcome in the present state of men's customs and conscience. The idea of treating human beings like cattle seems to us both odious and ridiculous. It shocks us and offends our feeling of personal dignity. We consider it incompatible with certain ideas that we have formed of ourselves and that we would on no account renounce.

We cannot, in any case, be under any illusion as to the gravity and extent of this conflict between humanism and "biologism", between the positive interests of the species and its moral convictions, between its genetic progress and its moral values. *From now on, man knows that he can work on man.* He knows the secret of how to improve himself in flesh as well as in spirit. It is in his power to become greater, and that with relative ease, with relative speed. At present he prefers to renounce this progress that lies within his reach, rather than achieve it by means that revolt him. But will he renounce it tomorrow, will he renounce it for ever?

Social conscience, in the mid-twentieth century, resolutely rejects the brutal selective methods proposed by a science of genetics that has freed itself from all sentimental or ethical prejudice. It must be admitted that the last few years have strengthened this sort of repugnance, since anything that suggests planned reproduction, "biological goose-stepping", inevitably evokes in the public mind a rightly-hated racism. Yet our social conscience is in constant evolution. There were protests against compulsory vaccination, against childbirth under anaesthetics. In our own day, there are protests against artificial insemination. As the science of heredity becomes better known, as reproduction loses its character of mystery and indecency, as man becomes more conscious of all he owes to technology in every sphere, as he begins, in his own interest, to "rationalize" procreation (once, for example, science has enabled him to select the sex of his children), he may accustom himself to the idea of human selection which at present seems so repulsive.

In 1930, the Russian biologist Ivanoff, the great specialist in artifical insemination, wrote: "It is a civic duty for the male population to sacrifice its life in the interests of its country in the event of external danger. It is possible that, in the future, it will be considered a no less noble duty for womankind permanently to participate in the large-scale implementation of positive eugenics."

May it not be that one day humanity, torn asunder by its physicians, will beg its biologists to restore to it, in quality, what it has lost in quantity?

For the moment, the biologist can do no more than familiarize the public with the facts about

heredity, so that as many minds as possible can reflect on these difficult problems.

It has been known for several years that certain elements (plasmagenes), which appear to play some part in the phenomena of heredity, are present in cellular cytoplasm. Although we do not know what relationship these plasmagenes bear to the genes of the nucleus, or what their importance in relation to the latter is, it is permissible to suppose that their "mutation" could cause perceptible modifications in the species. Here is another element of hope for the biologist who aims at transforming humanity.

In any case, whether through nuclear genes or through the genes contained in the cytoplasm, it seems certain that man will eventually bring about important structural reforms within his own organism.

He will have ample time to carry out this great task, provided he escapes falling a victim to the formidable methods of destruction that his own genius has created. Milliards of centuries must go by before cosmic evolution makes the earth uninhabitable for him, and during all this time biology will not cease to make new discoveries. When we consider those that have marked the last half-century, the wildest dreams concerning our domination over living matter become reasonable possibilities.

How far will the changes brought about in man by man be carried? Will the step from ourselves to the superman represent a single evolutionary mutation, or a difference in species, in kind, in family?

No sure reply can yet be given to these questions. It should not be forgotten, however, that a very slight increase in the volume of brain matter would suffice to change the destiny of humanity. A being who would bear the same relation to *homo sapiens* as that of the latter to Neanderthal Man would perhaps be capable of averting the danger with which the inevitable evolution of the solar system threatens our planet in the distant future.

Possibly, therefore, the ultimate destiny of man does in fact lie in the hands of the biologists.

We cannot, of course, be sure that they will succeed in creating a "super-human" being. Yet it must be admitted that this no longer seems beyond the bounds of possibility, now that, having been initiated into the methods of experimental genetics and embryology, we glimpse the means of influencing the subtle structure of our own cells.

So high an aim should suffice to give biology a unique place among the sciences. It is for other disciplines to enlighten, help, comfort—or destroy—mankind. It is for biology alone to "surpass" man and, by changing humans as thinkers, to change the very conscience of the universe.

Truly, it cannot be said that this is a science like any other, since it could, in the last resort, change the very organ within which science is created.

Extracts from La biologie et l'avenir humain, *Paris, Albin Michel, 1950.*

Abstracts. Science and Society

Works and Texts in the French Language (1900-50).

I. *General Works. Science and Progress*

665 AUGER, Pierre. "Le progrès scientifique dans le monde actuel". *Conférences du Palais de la Découverte*, Paris, 1950. 16mo, 22 pp.

Scientific progress moves in three cycles—invention, teaching and technology—which are unfortunately not synchronous. The author stresses the need for giving the public a better knowledge of the value and potentialities of science.

666 BLOCH, Marc. "Transformation des techniques comme problème de psychologie collective", in *Le travail et les techniques. "Journal de psychologie"*, 41st year, No. 1. January-March 1948. 144 pp.

Essay on the development of technology, which can be explained by reference to the internal structure of societies and to the interaction of the various groups of which they consist. Importance of technical data for the purpose of a concrete forecast of the future.

667 DE BROGLIE, Louis. "Science et Civilisation", in the review *Chemins du Monde. "Civilisation"*. Paris, Editions de Clermont, 1947.

Brief comparison between the development of science and that of human civilizations, in the intellectual and the material spheres. The reservations and anxieties bred in us by the progress of scientific knowledge must not allow us to forget that the cult of science remains one of the finest features of civilization, and that the work of science is an affirmation of man's spiritual primacy.

668/9 BUSSARD, Claude. "Notre royaume est de ce monde". *Vers le gouvernement de la science.* Preface by Marcel BOLL. Paris, Liberté, 1935. 16mo, 228 pp.

This work deals with the extension of scientific methods and the enthronement of the technicians, and with the latter's part in the solving of the social problems confronting mankind. It consists of 20 chapters, arranged in five parts. Part I, which deals with philosophy and especially metaphysics, explains the attitude of those scientists who refuse to admit that there are any limits to what science can achieve. Part II, which deals with contemporary technical and economic life, surveys the potentialities of modern technology and the obstacles which, owing to the law of personal profit, capitalism places in the way of socially useful technical progress. Part III describes a plan for the organization of a new State aiming, primarily, at rational economic production for the benefit of the community as a whole. The role of science in the conduct of public affairs, and the centralized organization of research and technical progress, are also discussed. Part IV shows that science does not confine itself to the physical world, but is beginning to take an interest in determining the conditions for harmonious living. It also suggests some remedies for social situations that cannot be disentangled so long as ethics remain a century behind technology and the philosophy of science. In conclusion, the author retraces the chain of events which has caused Greek "reason" to lose its influence for 2,000 years, and explains why we are still so impregnated with mediaeval traditions.

670 CHANLAINE, Pierre. "Les horizons de la science". *"Bibliothèque de philosophie scientifique"*. Conversations with well-known figures in the world of politics, religion and science. Paris, Flammarion, 1928. 16mo, 246 pp.

This work, which is easy reading, reproduces various discussions or interviews. It is mainly of historical interest. Particular mention may be made of conversations with Mussolini, with high Vatican dignitaries, with Dr. J. Louis Faure, Marconi, Major Charcot, Paul Painlevé, Louis Lumière, Louis Bréguet, Georges Claude, etc. Most of the conversations are on scientific progress and the benefits that a given discovery can confer on humanity, such as the discovery of the North and South Poles, television, aviation, etc.

671 CHAPPEY, Joseph. *Histoire générale de la civilisation d'Occident de 1870 à 1950.* Vol. I: 1870-1914. Vol. II: 1914-34. Vol. III: 1934-50. Paris, Presses Universitaires. 8vo, 393 pp.

Political and social history of Western civilization and of the upheavals that have recently overtaken it, with reference to its scientific, technical and economic foundations. Vol. I (1870-1914) is divided into five parts:

I. The development of Western civilization between 1870 and 1900, including several chapters on the history of the technological revolution, the conquest of energy, the development of science, etc.

II. The internal upheaval within the Western nations between 1900 and 1914, with a chapter on the rupture between technological progress and economic activity.

III. The sundering of the Western community between 1900 and 1914.
IV. The war of 1914.
V. The crisis of civilization, crisis of thought.
The drama of 1914 is here seen as the outcome of a systematic quest for specialization and of a split between scientific and technical thinking and moral thinking. These two orders of thought have progressed at different rates, and this difference became more marked after 1900, until it culminated in the Great War and the present laceration of Western thought. Volume I concludes with reflexions on the "dictatorship of technological thought". Volumes II and III have not yet appeared.

672 COLLIN, Rémy. *Message social du savant.* Paris, Albin Michel, 1941. 8vo, 350 pp.
A study of the importance of the scientific factor in social evolution. On the basis of a historical study of the relationship between science and society since classical antiquity, the author investigates under what conditions scientific progress can be compatible with the peaceful and harmonious development of societies and the human being. A study of the nature of science and of its repercussions in the field of metaphysics leads to an animistic concept of the universe. Importance of the social role of the scientist.

673 COMPTON, A. H. *L'énergie atomique, sa découverte et sa valeur humaine. "Les conférences de l'Unesco".* Paris, Editions Fontaine, 1947. 8vo, pp. 257-70.
Account of the first experiment which produced a chemical chain reaction, followed by the history of the discovery of atomic energy. Passing on to its consequences, the author contemplates the social, economic and human repercussions of the liberation of nuclear energy (destructive and constructive aspects), drawing particular attention to certain trends now becoming visible in society's evolution. At least three of these trends deserve notice. Science and technology are in process of turning the scientists into a team of specialists who, if they are to act effectively and even continue to exist, must needs collaborate with each other. That is the first trend, which leads us to increasing specialization accompanied by increasing co-operation between the groups of specialists. Society based on science demands technical knowledge and an ever greater capacity to establish human contacts, i.e. a specialized training and a wide measure of humanistic education. That is the second trend. But above all, a society born of scientific progress requires to be given adequate objectives. Only if those objectives are understood by all and deemed worthy of common effort toward them can free men be led to work together for their attainment. That is the third trend—the one which is of greatest importance for the progress of the human mind. The author points out that, while these trends have existed since the earliest days of modern science, it is the arrival of the atomic age that has given them a violent stimulus. He then shows us how they emerged in the course of the work on atomic energy, and goes on to examine the economic consequences which, sooner or later, will bring about world unity. Considerations on the possibility of a world government, and conclusion which clears the ground and calls on men to work together for a better existence.

674 CORRA, Emile. *L'avenir de l'humanité.* Paris, Editions de la société positiviste internationale, 1926. 8vo, 69 pp.
This is the last of a number of lectures on positive sociology. There is also a chapter dealing with the general method of anticipation in the field of science, and its application to sociology. The author quotes Auguste Comte's well known aphorism concerning the specific object of science: "To know in order to foresee in order to provide." It is this principle which should guide all attempts to discover the ultimate aim of the intellectual, moral and material development of mankind.

675 DELVAILLE, J. *Essai sur l'histoire de l'idée de progrès jusqu'à la fin du XVIII^e siècle. "Collection historique des grands philosophes".* Paris, Alcan, 1910. 8vo, XII + 761 pp.
Historical survey of the origins and development of the idea of progress until the moment in the nineteenth century when the doctrine of progress took shape. The work is divided chronologically: Antiquity, the Middle Ages, the Renaissance, the seventeenth and eighteenth centuries. It concludes with studies on English and German philosophy in the eighteenth century, and on the philosophy of the French Revolution.

676 DUBARLE, Dominique. *Le Christianisme et les progrès de la science.* Paris, Esprit, 1951. No. 9, pp. 300-30.
Science and contemporary man, as seen by a Christian. Value of science as providing a knowledge of matter, of life and of the mind, and as an instrument for the renewal of man's intellectual powers. Openings and dangers created by an era of scientific tyranny enslaving the less advanced groups of mankind from this point of view. The article concludes with a more detailed examination of the Christian standpoint and of the problems raised by the conquest of knowledge in relation to faith.

677 DUCLAUX, Jacques. *L'homme devant l'univers. "Bibliothèque de philosophie scient.".* Paris, Flammarion, 1949. 293 pp.
Historical survey of the problems encountered by man in his struggle with nature, problems whose solution has had happy results. Praise of scientific research, which can render our planet a desirable place for all men.

678 DUHAMEL, Georges. *Scènes de la vie future.* Paris, Mercure de France, 1930. 8vo, 250 pp.
Essay on America and American life, as characteristic of future civilizations. The future of our civilization, and especially our freedom, is threatened by scientific and technological advances which will soon spread from America to the Old World. Those who cannot fight against circumstance have not only the right but also the duty to issue a warning against this danger which, according to Duhamel, might well be summed up in the sally: "There are, perhaps, some hundred contagious diseases. Once we possess an effective vaccine, whose use will be compulsory, for each of them, we shall no longer suffer from the diseases themselves; we shall suffer from the constraints imposed on us by our legal systems; we shall suffer from good health."

679 EINSTEIN, Albert. *Comment je vois le monde* (As I see the world). Translated by Colonel Gros. *"Bibliothèque de Philosophie scientifique".* Flammarion. Paris, 1939. 258 pp.
Collection of about a hundred articles, interviews and letters, chosen so as to cover the various aspects of the great scientist's ideas. The items are arranged under five headings: As I see the world—Politics and Pacifism—Germany 1933—Judaism—Science. There is no need to stress the interest of such a collection, but it is to be regretted that none of the items bears any indication of date or origin.

680 FEBVRE, Lucien. *Continuité ou rupture de tradition? Le Monde,* 20 December 1949.
The advent of a new science in the first half of the twentieth century casts doubts on all the truths long since admitted, and widens the gulf between our present-day world and that of Auguste Comte's positivist science —a gulf that has never yet been bridged.

681 FRIEDMANN, G. *La crise du progrks, esquisse d'histoire des idées, 1895-1935.* Paris, Gallimard, 1935. 8vo, 284 pp. Many bibliographical notes.
History of the concept of progress in the twentieth century. This history is not only examined through a consideration of thinkers and philosophers, but is traced by reference to the technical, economic and human environment in which this concept of progress has developed. Long studies of the Taylor and Ford systems. There is an interesting appendix (pp. 239-48) on "some authors of the ideas of progress from the seventeenth to the end for the nineteenth century". A basic work.

682 FURNAS, C. C. *Le siècle à venir.* Translated from the English by A. M. Petitjean. Collection *"L'avenir de la science".* Paris, Gallimard, 1938. 8vo, 286 pp.
Critical essay, containing personal reflexions, on the

crisis of the modern world. Science and technology have given birth to a complex of conditions and have caused disturbances which require special solutions. The author, an American, studies this phase in poor social organization—"the mark made on civilization by technology"—on the basis of observations of life in the United States (1938). After listing in detail the various relevant questions, he suggests the following main remedies: unemployment insurance, the introduction of a minimum standard of living, and the organization of leisure. In short, the rhythm of our life should be synchronized with that of our machines, and this problem should be solved jointly by the sociologists and the scientists.

683 GEORGE, André. "L'homme devant la science moderne". *Revue des questions scientifiques*, Fifth series, Vol. X, October 1949. pp. 481-97.
A picture of modern science, and an essay on man's position in relation to it. The prodigious development of science, and especially the use of nuclear energy, must throw doubts on the concept of the "human scale". The main features of this development are illustrated with several examples. The speeding-up of science and the historical significance of Lord Rutherford's work are the subject of consideration. So far as economic and social repercussions are concerned, science has entered the era of large-scale output, and from now on everything will tend to make it an instrument in the service of the State. Yet, as is shown in the second part of the book, the tremendous power of modern science inevitably causes a general movement of reaction against scientific progress—a movement inspired by fear. The doctrine of "science for its own sake" is criticized, since the gap between pure science and its application is being gradually reduced. The problem at issue is that of controlling scientific activity in general. Since it is inconceivable that man should give up science, it is his duty—especially if he is a Christian—to adjust his responsibilities to his new powers, so that destruction even more terrible than in the past may be avoided.

684 GIRARD, Pierre. *Le rôle social de la science.* Paris, S.A.L., 1946. 14 pp.
Science is not a luxury, and savings made at the expense of scientific research are paid for dearly. Science is preparing the world of tomorrow; the course set for it will decide whether there is to be a war even more appalling than the last, or whether the world is to be a place where abundance reigns.

685 HOGBEN, Lancelot. *La science pour tous* (Science for All). Translation and preface by René Sudre. *"Bibliothèque scientifique"*. Paris, Payot, 1946. 2 vols., 8vo, 660 and 687 pp., with 267 and 216 drawings by J. F. Horrabin.
An introductory scientific textbook, designed to emphasize the close interdependence of progress in knowledge and of the mechanism of society. In a society where science is the most effective medium of action, man, whatever his social level, should know in what way he can make use of our knowledge to improve his life. From this practical point of view, the main results produced by the physical and natural sciences are set down with almost mathematical precision. The facts of the history of science are dealt with in detail, since in Hogben's view science cannot be separated from its history, and a knowledge of its record of trial and error provides us with a better understanding of its scope and trend. Science is not merely the conquest of truth; it is, even more, an instrument of social justice. A basic work, made attractive by its numerous illustrations. It is divided into five parts:
(1) The conquest of measurements of time and space.
(2) The conquest of "substitutes".
(3) The conquest of energy.
(4) Victory over hunger and disease.
(5) The control of behaviour.

686 HUXLEY, Aldous. *La science, la paix, la liberté.* Translation by Jules Castier of *Science, Liberty and Peace*, published by Harper Brothers, New York, 1946. Monaco, Edition du Rocher (2 rue des Vieilles Casernes). 16mo, 100 pp.
An essay on the role of science in the evolution of contemporary societies. Science is one of the factors in the progressive centralization of power and the correlated reduction of human liberties. Studies and surveys on centralization, war, nationalism, international settlements, and the international organization of science. Science may be held to be an obstacle to the development of the human personality, not because of its nature, but because it increases the power of the mighty—that is, in our present-day world, of the forces of oppression.

687 HUXLEY, Julian. "Science et besoins sociaux" (Science and Social Needs) in *Le Progrès scientifique*, by Sir James JEANS, Sir William BRAGG, Julian HUXLEY, etc. Translated from the English by Paul Couderc. Paris, Librairie Félix Alcan, 1938. 8vo, 198 pp.
The social function of science. The distinction between pure science and practical science is invalid. Theory always, in the end, leads to practice, and practice in its turn may reveal errors of theory and stimulate reflexion and research. Examples illustrate the existence in the modern world of this twofold current, with its economic repercussions, its defects and its errors. The lack of co-ordinating bodies, and the shortcomings of the State, are felt in many fields, especially in medicine, where increased knowledge ought to lead to a great improvement in health. The picture is one of science frustrated, largely exploited for profit, and diverted from its proper course by various kinds of pressure due to the social system. The next stage in progress requires that science be studied as a social function, with a view to its application being controlled and developed in the best possible way for mankind.

688/9 LANGEVIN, Paul. Preface to *L'évolution humaine des origines à nos jours.* Paris, Quillet Editeur, 1934.
Reflexions on the meaning and value of science. If the world is to adapt itself, as it must do, to the new conditions created by science, social systems must recognize, to the full, the human value of science. Dangers arising from intoxication with technology and from the over-rapid development of industry, without machinery being placed at the service of all. Growing influence of scientific disciplines and methods, and of the rational attitude, in the study of human problems. This influence is such that no happy balance can now be expected between the rights of the individual and those of the community unless a code of ethics on a scientific basis is evolved.

690 *Les grands courants de la pensée mathématique*, presented by F. LE LIONNAIS, *"L'humanisme scientifique de demain"*. Paris, Cahiers du Sud, 1948. 8vo, 553 pp.
Deals with present-day mathematical research and outlook. Section III, "Influences", seeks to define the role of mathematics in the training of the human mind and in the material and spiritual development of civilizations.

691 LEPRINCE-RINGUET. "L'ère atomique, nouvel âge de l'homme", *Revue des questions scientifiques*, 20 July 1951, pp. 321-36.
General remarks on the contemporary progress of science and technology, and on the new ways of life and thought necessitated as a result. The author, who takes a firmly optimistic view, strives to show that the displacement of one type of man by another, dangerous as it may be, is not necessarily an evil, and that such a development does not exclude a Christian conception of man. In any case, the fact is undeniable, and it is useless to protest. We shall be better advised to take our place in a general movement which, one day, perhaps many years hence, will introduce a new era of happiness and fulfilment for man.

692 MOUREU, Charles. *Discours et conférences sur la science et ses applications.* Paris, Gauthier-Villars. 1927. 8vo.
This volume assembles speeches and lectures on various subjects in the field of pure and applied science. In these studies, and in certain others presented in the form of articles, the author tries to show the increasingly important part played by science in modern life, and

emphasizes the need for encouraging scientific research, on which, in the last resort, all progress in agriculture, industry, medicine and hygiene depends. The author frequently considers the matter from the national point of view; he advocates a number of measures and decisions calculated to increase France's scientific output and hence her material power.

693 MULLER, H. J. *Hors de la nuit, vues d'un biologiste sur l'avenir.* Translated from the English, with a preface by Jean ROSTAND. Paris, Gallimard, 1938. 186 pp.

The repercussions of applied science, especially biology, on the future of mankind. Man's material, cultural and biological progress depends, mainly, on a complete economic and social change, designed to establish societies on a co-operative basis. In these reformed societies, advances in biology will enable individuals and the species as a whole to be improved, not only by reducing the number of the unfit or by acting on health, longevity, etc., but also from an entirely new and constructive angle, by altering the genetic potential of the species and by changing the circumstances of procreation. Various considerations on the circumstances and results of such changes as they affect women and their social position. Some chapters of this work were written in 1925, but the problems it deals with still exist.

694 NICOLLE, Jacques. *La science au service de l'émancipation de l'homme.* Preface by H. NEVEU. Algiers, Liberté, 1945. 39 pp.

Brief sketch of the history of science. All discoveries have benefited humanity, even those whose harmful use has been underlined. Thus the invention of dynamite enabled tunnels to be made. It is therefore important to eliminate anything that might hamper the development of science, especially the secrecy to which certain research work is subjected for military or commercial reasons.

695 PELLETIER, Jean-Louis. *L'âge des mathématiques. Collection "Science et humanité".* Paris, Calmann-Lévy, 1949. 16mo, 348 pp.

Study of the main aspects of mathematics and of its growing importance in our daily life—its cultural and spiritual value. Mathematics, which is an abstract science *par excellence*, never loses contact with reality. It is on the basis of this twofold value—practical and spiritual—that the author describes our own time as the Age of Mathematics.

696 PERRIN, Jean. *La science et l'espérance.* Preface by Louis de BROGLIE and Léon BLUM. Paris, Presses Universitaires, 1948. 16mo, 216 pp.

Posthumous collection of writings by Jean Perrin. The subjects dealt with vary. Sections headed "Scientific Research", "Teaching" and "The Defence of Democracy and Peace" contain a series of studies or speeches on the role of science in maintaining peace and democracy in modern civilizations. All these studies centre round the great future opened up to mankind by scientific progress. The preface constitutes two biographies of Jean Perrin, one describing his scientific work, the other his career as a militant Socialist.

697 ROUSSY, Dr. *Science et démocratie.* A lecture-speech given at the prize distribution and reopening of the Polytechnic Association classes. (Hotel de Ville section), Paris, J. Rousset, 1902. 8 vo, 32 pp.

Science as the fount of progress. All our assets, whether intellectual, moral or material, depend on its development. Necessity for a practical popular education. Some historical notes on popular education societies in the eighteenth and nineteenth centuries.

698 RUSSEL, Bertrand. *L'esprit scientifique et la science dans le monde moderne.* Translated from the English by S. Jankelevitch. *Collection "Janus".* Paris, J. B. Janin, 1947. 16mo, 248 pp.

A study of the characteristics of contemporary science and its social implications. The first part describes the nature of scientific knowledge, its methods and its effects on metaphysics and religion. The second part deals with the problem of our ascendancy over the inanimate world, the domain of biology and physiology, over the world of psychology and over human communities (propaganda, education). Many concrete examples are given for each of these categories. The author concludes that the advancement of science is admirable so long as it does not run counter to the major impulses which give a value to human life. When it does so run counter, it becomes a cruel tyranny, and the world is at present in danger of succumbing to this tyranny.

699 SOREL, Georges. *Les illusions du progrès. "Etudes sur le devenir social".* Paris, Marcel Rivière. 5th edition, 1947 (First edition published in 1908). 16mo, 390 pp.

A Marxist critical study of the progressist philosophy of the eighteenth century. There are several examples of the scientific treatment of social problems in the chapter entitled "Science in the eighteenth century," and a long account of the first applications of mathematics and the theory of probabilities to social problems.

700 VALÉRY, Paul. "Propos sur le progrès", in *Regards sur le monde et autres essais.* Paris, Gallimard, 1945. pp. 167-74.

An attempt to define the idea of progress consisting mainly in an increase in man's mechanical skill and the accuracy of his forecasts. Importance of "novelty", which is taking the place hitherto held by tradition and historical fact. Man without a background. Downfall of common sense.

701 WEBER, Louis. *Le ruthme du progrès.* Paris, Félix Alcan, 1913. 8vo, 311 pp.

An attempt to explain the problem of progress, and proposals for a classification of the chief elements in its evolution. The law of the three states of positivist philosophy, which serves as a basis for discussion, is replaced by the idea of the alternation of two phases of intellectual progress (technical and speculative) which are brought to light by modern science and industry, from which, at the same time, they proceed. The evolution of progress is characterized by a law of the two states.

702 WHITEHEAD, A. N. *La science et le monde moderne.* Translated from the English by A. d'Ivery and P. Hollard. Paris, Payot, 1930. 8vo, 271 pp.

A study of the various aspects of Western civilization during the last three centuries, in so far as it has been influenced by the development of science. In the conception of the world held by the different communities, the point of view of a cosmology derived from science has gained supremacy over all others. The dominant idea of this book, consisting chiefly of a series of eight lectures (Lowell lectures), is that one of the functions of philosophy being to supply the critique of cosmologies, it is thus for philosophy to maintain a rational control over progress. The first chapters deal with the conditions which led to the rapid strides made by science in the seventeenth century (the origins of modern science, mathematics and the history of thought). The author then retraces the advance of thought from the seventeenth to the nineteenth century, emphasizing that the doctrine of materialism provides a sufficient basis for scientific conceptions. He describes contact between science and the Romantic movement, the development of technology and physics during the first half of the nineteenth century, and finally the theory of evolution combined with the general advance of biology. A chapter on "Science and Philosophy" deals with the influence of science on the trend of philosophic ideas during the last few centuries, and the change wrought in religious ideas by scientific advances. The book concludes with a study, from a lofty standpoint, of the conditions necessary for social progress. These conditions are correlative to the influence of science on the problems of civilized societies: the dangers of professionalism which it entails, and the need for a revival of creative imagination.

703 ZIMMERN, Sir A. *L'avenir de la civilisation. "International Studies"*, Oxford. Oxford University Press, 1944. 32 pp.

Re-issue of a pamphlet, published in 1939, whose appositeness was clearly shown by the last war. Necessity of adjusting social and political customs, and the habits of mankind in general to the new living conditions resulting from the Industrial Revolution.

COLLECTIVE AND ANONYMOUS WORKS

704 BROGLIE, Louis de; THÉRIVE, André; CHARMET, Raymond; DEVAUX, Pierre; DANIEL-ROPS, SERTILLANGES, A. D. *L'avenir de la science. "Présences".* Paris, Plon, 1941. 8vo, 313 pp.

Essay on the effects of science on the future of humanity. Louis de Broglie. "The Future of Physics", pp. 1-26. Modern physics contribute new elements to philosophic thought, thus opening up avenues which may lead in the near future to an understanding between "the devotees of science and the servants of the spirit".

R. P. A. D. Sertillanges. "Science and Scientism", pp. 27-76. The limits of scientism. The betrayal of the true values of mankind.

Raymond Charmet. "The Modern Myth of Science", pp. 77-162.

Pierre Devaux. "Prophets and Inventors", pp. 163-214. Contemporary advances in science.

André Thérive. "The Romance of Science", pp. 215-48. Study of the conditions in which scientific and technical advances could be made to serve mankind instead of turning against it.

II. *Science and Society*

Under this title are grouped works dealing with the influence of science on the life of societies and individuals. The first chapter, "Science and the life of societies", describes economic, political and social changes brought about by scientific and, hence, technical advances. The second chapter, "Science and the human person", deals with the effect produced by such changes, and the problems to which they give rise, on the life of the individual. The third and last chapter, "Science and culture", concerns works which have brought to light the part played by science in culture, in the development of man's conception of the universe and of life, and in his moral and religious behaviour.

SCIENCE AND THE LIFE OF SOCIETIES

1. POLITICAL, ECONOMIC AND SOCIAL PROBLEMS

705 AUDUBERT, René. *Les applications actuelles de la chimie,* with an introduction by Mr. Urbain, Member of the Institute. Collection *"La science dans la vie moderne".* Paris, 1924. 8vo, 183 pp. Many illustrations.

Popular treatise on the following subjects: agriculture, food, building and decorating materials, textiles, paper, leather, lighting and heating, perfumes and precious stones.

706 BOLL, Marcel. *La chimie. Au laboratoire et à l'usine, dans la nature et dans la vie.* Paris, Larousse, 1935, 298 pp.

A general survey of the various aspects of chemistry and of its importance in the contemporary world. Quoting familiar examples, the author provides a popular and easily understandable introduction to modern theory and practice in a science which is assuming more and more importance in present-day life.

707 BROGLIE, Louis de. *La science pure, source féconde des produits de l'industrie.* Lectures of the Society for the Encouragement of National Industry. Formal reopening meeting, 6 November 1947. 1948. 4to, 15 pp.

Brief survey of the industrial opplication of science. The main examples quoted are of recent date and chiefly in the domains of electronics, wave mechanics and atomic research.

708 BUREAU, Paul. *La crise morale des temps nouveaux.* With an introduction by Mr. Alfred Croiset. *"Etudes de morale et de sociologie".* Paris, Bloud et Cie. 1908. 16mo, 462 pp.

This work concerns the need for higher moral standards and the relationship between individual morality and the general good of the community. The author first draws a depressing picture of the low moral standards of our society at the beginning of the century and then tries to explain their causes. He attributes them to the mistakes and excesses of two rival schools: progressive thinkers and traditionalists. But, contrary to the doctrine that natural forces co-ordinated by science must automatically lead to the triumph of virtue, the real signs of moral restoration are to be seen in conscious and unconscious manifestations of religious feeling.

709 CHAPELON, Jacques. "Les mathématiques et le développement social" in *Les grands courants de la pensée mathématique,* by L. Le Lionnais. Paris, Les Cahiers du Sud, 1948. pp. 511-19.

Historical survey of the influence of mathematical development on social development, and vice versa. The

two always run parallel and continually influence one another.

710 CHOUARD, P. "Progrès technique et évolution sociale en agriculture". *Économie et humanisme, Cahiers d'économie humaine*, 10th year, new series, 1951, No. 1, pp. 15-25.
Agriculture, which is the meeting-place for many branches of science, is becoming one of the most difficult and complex of activities. The improvement of rural life, through technical progress. General survey of the main ways in which agriculture has progressed: mechanization, fertilizers and the rotation of crops, irrigation, biological equipment, antiparasitics, hormones, etc.

711 CROWTHER, J. G. *Science et structure sociale.* Lectures at the *Palais de la Découverte*, 13 December 1945. University of Paris, 1946. 8vo, 20 pp.
Historical account of the relationship between the social structure and scientific knowledge. Theological cosmogony goes with a feudal social structure, whereas modern science is the expression of the commercial and industrial society which started to develop in Europe at the time of the Renaissance. The organization of scientific research. The scientist's role and responsibility. The atomic problem.

712 DAMAYE, Henri. *Problèmes sociaux et biologie.* Paris, Félix Alcan, 1929. 16mo, 253 pp.
A study on the development of the human mind by science, and on the improving of our social standards through biological research. Owing to the popularization of science, modern man is tending more and more to favour reality rather than fiction. Although this work considers the various problems mainly from a psycho-sociological standpoint, it also contains very interesting observations of a more general nature, such as those drawing a parallel between literary and scientific culture. The teaching of science, in keeping abreast with the teaching of living languages, is simply playing the part which the future has reserved for it.

713 DELEVSKI. *L'évolution des sciences et les techniques industrielles.* Paris, Marcel Rivière, 1939.
Scientific progress has very often been divorced from any practical considerations, and there are relatively few examples of flashes of genius having produced new techniques: as a rule, it is scientific discoveries resulting from theoretical studies that lead to inventions in the industrial field. The more science becomes organized, the more possible it appears to replace chance inventions by organized scientific research.

714 DEMOLON, Albert. *L'évolution scientifique et l'agriculture française. "Bibliothèque de philosophie scientifique".* Paris, Flammarion, 1946. 329 pp.
At the beginning of the book, the author describes the particular features of agricultural research and the institutions dealing with it (ministries, institutes, agricultural colleges, schools). In the second half of the book, he passes on to more technical subjects: climatology, soil science, methods of fertilization, mechanization. The last chapter relates to agriculture in the colonies. In conclusion, the author demonstrates the need for a coherent agricultural policy: modern science opens the door to a more industrialized form of agriculture, less dependent upon unknown factors.

715 DUCROCQ, Albert. *Les horizons de l'énergie atomique. "Science et Humanité".* Paris, Calmann-Lévy, 1948. 12mo, 280 pp.
See *Impact*, Vol. I, No. 3-4, October-December 1950. pp. 136-37.
In the preface, the author calls to mind the atomic psychosis of the years 1945-46 and the feeling of relief tempered with disillusionment which followed the Bikini explosion. He notes the general public's lack of interest in research on the industrial use of nuclear energy, but does not attempt to picture the various phases of man's adaptation to the atomic era which lies ahead.

716 FAVRE, Adrien. *Les origines du système métrique.* Paris, Presses Universitaires, 1931. 8 vo, 242 pp.
History of the adoption of the metric system in France by the Constituent Assembly of 1789, and its consequences. Although somewhat obscure in places from the historical point of view, this work shows how much the new system was needed in eighteenth-century France, and demonstrates its scientific validity and its importance from the point of view of international intellectual co-operation.

717 FEBVRE, Lucien. "Les techniques, la science et l'évolution humaine", *Europe.* Paris, August 1938. No. 188, pp. 494-514.
Criticism of the concept of pure science: there is always a connexion between science and social conditions. We are living in an age of scientific revolution. It is untrue that technological progress always follows immediately upon scientific progress: the seventeenth century produced Descartes and Pascal, but there were no important technical inventions at that time.

718 FOURASTIÉ, Jean. *La civilisation de 1960.* Collection *"Que sais-je?".* Paris, Presses Universitaires, 1947. 16mo, 118 pp.
Progress made since 1830, and beginnings of the Industrial Revolution. Description of changes which are now taking place in human societies as a result of that progress, and comments on possible future developments.

719 GILLE, Bertrand. *Les origines de la grande industrie métallurgique en France.* Introduction by Edouard DOLLÉANS. Paris, Domat-Montchrestien, 1947. 8vo, 212 pp.
Nature of the iron industry. Early history. Copious documentation and many bibliographical references. The author begins with a brief account of the various stages in the development of the iron industry before Colbert, accompanied by an analysis of the laws governing the working of iron mines and the organization of iron production before 1661. He then passes on to consider various factors connected with the iron industry: physical factors (raw materials) and technical factors, considered in relation to technical literature, metallurgical chemistry, blast-furnaces and their operation, forges, steel and mechanization; and, lastly, commercial, financial and social factors. The last part of the book describes the early history of the industry and gives an account of industrial areas in various parts of France.

720 GUILLET, Léon. *L'évolution de la métallurgie. "Nouvelle collection scientifique".* Paris, Alcan, 1928. 196 pp., 37 fig.
Account of progress achieved since 1850 both in metallurgical methods and in the products obtained. The author demonstrates in particular how methods of manufacturing and treating metallurgical products have changed as a result of scientific research.

721 HAYNES, William. *L'âge de la chimie.* Paris, Librairie Arthème Fayard, 1948. 16mo, 381 pp., figs., portraits.
A book providing interesting information for the cultured public. The author deals with extremely varied subjects, ranging from expensive perfumes to choice flavourings, from second-hand clothes shops to fashionable dressmakers, from sulphamides to india-rubber, and from plastic substances to synthetic colouring matter.

722 KROPOTKIN, Peter A. *La science moderne et l'anarchie. "Bibliothèque sociologique"*, No. 49. Paris, P. V. Stock, 1913. 18mo XI + 391 pp.
Anarchy as an inevitable consequence of scientific development. Anarchy takes its stand on a mechanical interpretation of all natural phenomena, including the life of human societies, in an attempt to apply general natural science data to the study of human institutions. This study will lead to a better understanding of the march of mankind and will bring within the reach of each individual, in every human community, the greatest possible amount of happiness, which is the ultimate aim of anarchism. History and definition of relationship between anarchy and scientific knowledge. Communism and anarchy. The State; its historic role.

723 LABARTHE, André. *La vie commence demain.* Paris, René Julliard, 1947. 16mo, 271 pp.

Report on the present and future situation of the United States. Consequences of the use of atomic energy, from the point of view both of social organization and of human geography. Predictions seem extremely likely to be fulfilled.

724 LAFITTE, Jacques. *Réflexion sur la science des machines.* Preface by P. ARCHAMBAULT. *"Cahiers de la nouvelle journée".* Paris, Librairie Bloud et Gay, 1932. 8 vo, 162 pp.
An outline for a "philosophy of the machine". Machinery is now a sort of kingdom, characterized by forms of organization and evolutionary processes very similar to those of the animal world. Yet it remains linked to "universality" by and through man, intimately associated with his destiny, his natural and acquired needs, the possibilities opened up by his knowledge, the social structures he has built up, and his spiritual impulses. Hence, the science of the machine must rest upon foundations comparable to those of the natural sciences. At least a philosophic knowledge of these sciences and their methods is therefore, in the author's view, essential.

725 LAIGNEL-LAVASTINE. "Le rôle des médecins dans les origines intellectuelles de la révolution française". *Thalès,* III, 1936. pp. 15-30.
Some detailed considerations supplementing Daniel Mornet's book, and a study of the contributions made by doctors to the current of ideas that preceded the Revolution. Certain of these men played important roles and expressed personal ideas in which the influence of their medical studies may be discerned (Quesnay, La Mettrie, Helvétius, etc.), while others spread quite original ideas. The influence of Tronchin, Voltaire's doctor, over his patient, and Rousseau's relationship with his doctors, are important aspects of the part played by medicine in preparing the Revolution.

726 LANGEVIN, Jean. *"Science et industrie",* in *A la lumière du Marxisme,* by Jean BABY, Marcel COHEN, Georges FRIEDMANN, etc. Introduction by Dr. H. WALLON. Paris, Editions sociales internationales, 1935. 8vo, 312 pp. Part I. pp. 108-15.
A study of the influence of the physical sciences on industry, and of the reciprocal influence of industry on the general development of those sciences. Optimistic conclusions as to the future of this interaction, supported by quotations from Marxist works.

727 LEVADITI, Constantin. "La chimie triomphe des grands fléaux sociaux". *Almanach des sciences,* 1948, pp. 112-17. Paris, Editions de Flore et de la Gazette des Lettres, 1948. 16mo, 256 pp.
A resumé of the latest uses of chemical therapy and antibiotic substances in the struggle against the great social scourges (with the exception of cancer).

728 LOMBROSO, Gina. *La rançon du machinisme.* Translated from the Italian by Henry Winkler. Preface by Guglielmo FERRERO. Paris, Payot, 1931. 16mo, 414 pp.
A study of the problems raised by the development of mechanization. Civilization as it appeared at the dawn of the eighteenth century, during which the economic, social and political conditions essential for an industrial system began to be established. After explaining how and why mechanization triumphed, the author describes the tragic consequences of this triumph—unemployment, pauperism, depopulation of the countryside, disease, moral and intellectual decadence, etc.—and recommends a struggle against the "hypertrophy" of industry and its existing tendencies, in order to bring about an era of justice and social progress.

729 MARSAIS, Paul. *La défense de nos cultures.* Collection *"Que sais-je?".* Paris, Presses Universitaires de France, 1949. 16mo, 127 pp.
Short history of the question, followed by a statement describing the dangers threatening the various civilizations, and the means provided by science, if not for escaping them, at least for reducing their effects.

730 MORNET, Daniel. *Les origines intellectuelles de la révolution française (1715-87).* Paris, A. Colin, 1934. 552 pp. Bibl.
The French Revolution was the outcome of a long period during which an "enlightened majority", which saw the faults in a régime, sought means of transforming that régime and succeeded in moving public opinion. This book, which is the fruit of 15 years' work, is a detailed study of the progress of the new outlook within the limited class of the bourgeoisie and among the wider classes of the population, which were to take part in the Revolution.
Unfortunately from our point of view, the author, who is a professor at the Sorbonne, is mainly interested in the role played by the intellect in general, and treats of science only incidentally, when he studies the numerous philosophers who were at the same time scientists (D'Alembert, Helvétius, Diderot, Voltaire, etc.).

731 NEF, John U. *La route de la guerre totale. Essai sur les relations entre la guerre et le progrès humain.* Paris, A. Colin, 1949. (Published by the Fondation nationale des sciences politiques.) 8vo, 162 pp.
An historical essay on the relationship between the thrust of industrial civilization, the alternating of war and peace in Europe, and the speculations of the Western mind. The author, who is Professor of Economic History at the University of Chicago, criticizes the traditional conception of the Industrial Revolution, which actually took place much more gradually than is generally supposed. Today, the development of industry is no longer synonymous with social or intellectual development: the proposition that industrial progress leads to war is far truer than that war stimulates industrial progress. If we are to avoid total war, with all its consequences, we must control industrial progress and adapt it to social and intellectual requirements.

732 POINCARÉ, Lucien. *L'électricité.* Paris, Flammarion, 1907. 12mo, 297 pp.
A complete and detailed inventory of the different uses to which electricity was put at the beginning of this century. A statement of the hopes of that period; belief in a happy solution of the great economic problems, and in increased brotherhood and understanding between the peoples. After becoming the main factor in industry, electricity would transform agriculture (irrigation, drainage, agricultural machinery) and become, morally and economically, the "great liberator", by freeing man from enslavement to nature.

733 RICHARD, Lucien. *L'union de la science et de l'industrie.* Dijon, Imprimerie Jobard, 1919. 8vo, 23 pp.
An interesting pamphlet on the question of the union of science with trade and industry in 1919. The first part deals with the establishment of experimental and research laboratories, and collaboration between scientists and industrialists. The second part shows the value to industrialists and traders of a knowledge of economics and social science, and of their application to world problems. Fraternalist point of view on the running of business concerns and the necessity of welfare work. The future activities of commerce and industry demand from French leaders in this field a far greater measure of daring in thinking and planning.

734 ROUX, Edmond. *Energie électrique et civilisation. "Bibliothèque de philosophie scientifique".* Paris, Flammarion, 1945. 16mo, 266 pp.
Electricity as the determining factor in modern civilization. Its history, from its discovery up to its universal application in our own day. Fundamental and permanent characteristics of the electric power industry. Circumstances required for its organization. 1935-45: the crisis and the war. Post-war problems. An examination of the various questions at issue shows that electric power organization is a crucial problem in a modern State.

735 SORRE, Max. *Les fondements de la géographie humaine.* Vol. II. *"Les fondements techniques".* Paris, Colin, 1950. 2 parts; (1) 8vo, 608 pp., 35 illustrations and maps; (2) 8vo, 430 pp., 27 illustrations and maps, index.

The second part of Volume II of this basic work deals with the techniques of producing and transforming raw materials, from the simplest forms of animal, vegetable and mineral exploitation up to the most complex forms known today. This book is a mine of information; there is an essay on the relationship between techniques and structures or types of life, a study of social factors in the concentration and dispersion of the principal industries, etc. The problem of humanity's future in relation to scientific and technical improvements. For Vol. II, Part I, see *Impact*, Vol. II, 1951, No. 1.

736 VASSAILS, Gérard. "Atome et politique" in *Science bourgeoise et science prolétarienne*. Paris, Nouvelle Critique, 1949. 48 pp., pp. 15-33.
A study of the progress of science in relation to the evolution of humanity. Science and humanity are subject to the same forms of oppression, as is shown, for example, by the slow and difficult victory of experimental physics over speculative physics. At present there is an attempt to build up idealistic theories on the indeterminate character of the atom, and to make it play a political role by justifying the worst theories. Science is the servant of industry, which subordinates it to its immediate selfish needs.

737 ZISCHKA, Anton. *La science brise les monopoles*. Translated by F. Kroll. Preface by Francis DELAISI. Brussels, Editions de la Toison d'or, 1941. 16mo, 391 pp.
A commentary on the results obtained by science. After having gained the victory over chance, tyranny and violence, science has still to defeat the monopolies—a veritable struggle against the hydra-headed monster, since the increase in our knowledge constantly provides these monopolies with new opportunities. The view taken as to prospects is optimistic.

COLLECTIVE AND ANONYMOUS WORKS

738 "Paysans d'hiers, agriculteurs de demain", special number of *Economie et humanisme, "Cahiers d'économie humaine"*, 10th year, new series, 1951. No. 1, 103 pp.
A series of studies on rural development in relation to technical progress. Among the contents: "From peasant to agriculturists", P. GRANDIN; "Technical progress and social development in agriculture', P. CHOUARD; "Vigilance in mechanization in agriculture", ARTAUD; "Capitalism in agriculture, as making for technical progress and dehumanization", DESHAUT; "Technical progress changes the face of an agricultural region" (transition from traditional to modernized agriculture in the district north of Rome, and its effects on the standard of living and the mentality of the population), GARDELLE.

2. WAR AND PEACE

739 BAXTER, James Phinney. *Les secrets de la science américaine*. Translated from the English. Paris, Corréa, 1948. 268 pp.
A description of the work of the American Office of Scientific Research and Development, founded in Washington in June 1940. An account of combined effort showing noteworthy achievements in radar and the counter-measures it has provoked, in rockets and all the appliances of air and submarine warfare. Several chapters are devoted to the role of chemistry in war, particularly those dealing with blood and blood substitutes, with penicillin, insecticides and the extermination of vermin. Lastly, there is a section on the atomic bomb: its construction, operation and development.

740 BUSH, Vannevar. *Les armes d'aujourd'hui et de demain*. Translated from the English by Dominique Guillet and L. Lazard, with an introduction by André MAUROIS. Paris, Calmann Lévy, 1950. 8vo, 303 pp.
An historical account of the important part played by the "physicists" in warfare, showing the relationship between political freedom and modern weapons. The author considers that the new trend in the art of war gives democracy a considerable advantage over dictatorship. A comparative study of German and American research work on the atomic bomb indicating the scale of America's progress in this field. The book gives facts about the extent of the damage that can be done by various armaments, possible uses of robot aircraft and biological warfare. On the whole, a valuable and well-documented work.

741 HALDANE, J. B. S. *Science, marxisme et guerre*. Translated from the English by Jules Castier, with an introduction by Professor Marcel PRENANT of the Sorbonne. Paris, Editions du Pavillon, 1948. 16mo, 317 pp.
A collection of essays designed to illustrate the Marxist conception of progress. Science, by revealing to us the nature of Man as well as of the physical world, has enabled us to act in the light of knowledge and thus to achieve true freedom. Identified with dialectic materialism, which includes the fertile and valuable elements of idealist philosophy, and in contrast to the science of war, science will become man's chief weapon for the conquest of universal happiness, in a world community based upon socialism.

742 LANGEVIN, Paul. "L'ère des transmutations". *La Pensée*, No. 4, July-September 1945. pp. 3-15.
In this article the renowned scientist, writing shortly after the explosion of the first atomic bomb, says: "We are in fact witnessing, in a particularly dramatic form, the dawn of a new era: the era of induced transmutation."
He gives a brief outline of the history of atomic research and points out that war is responsible for turning that research towards military ends. He hopes that, with the restoration of peace, atomic fission will be used solely for the liberation of mankind.

743 LANGEVIN, Paul. *La science et la paix*. Paris, Quadrige, No. 5, February-March, 1946, pp. 15-19.
Science is blamed for bringing about, and worsening, crises and wars. But even scientific discoveries made for warlike purposes end by helping mankind. With advances in knowledge wars have of necessity spread, attaining a national, then a continental and finally a global scale; "one of the reasons which makes me hope for the end of warfare is the fact that the last war spread over the whole world and could go no further; I have faith in the main trend of the evolution of human life".

744 NAHMIAS, E. *Artillerie atomique*. Paris, Ch. Béranger, 1947. 12mo, 120 pp.
A practical "popular" science work for the general public, giving a general picture of present techniques in nuclear physics and their application. The book is addressed to the "man of the atomic age" who sees the repercussions of modern physics research on the life of the peoples and is concerned to form an opinion of its usefulness and its beneficial or dangerous nature.

745 PUJADE, Henry. *Le radar, la science en guerre*. With an introduction by Pierre DAVID. Paris, Revue d'optique théorique et instrumentale, 1947. 8vo, 159 pp.
Translation of a report by the Information and Scientific Research Services of the American War and Navy Departments. The account of radar is profusely illustrated. Its future uses as a safety device in air and ocean navigation, and for purposes of modern warfare, are discussed. Indeed, the history of radar, as the introduction affirms, leads to the conviction that technical progress in one branch alone can increase the efficiency of every weapon of war to an extraordinary degree, and that backwardness in a single branch may entail irreparable consequences.

746 ROUGEMONT, Denis de. *Lettre sur la bombe atomique*. Paris, Gallimard, 1946. 16mo, 131 pp.
The Hiroshima bomb gave rise to this little book. Times have changed a great deal since men went in terror of the Millennium, but "by measuring the superhumanly

gigantic we have killed imagination". We scarcely dare think of all the avenues theoretically opened up by the atomic bomb. Only by uniting can the nations of the world be saved from the Apocalypse.

747 SAGERET, Jules. *La guerre et le progrès.* Paris, Payot, 1917. 250 pp.
This book, which appeared at the end of the first world war, makes interesting reading today, for it raises problems and expresses hopes that are still extant. The author emphasizes the beneficent results of progress, which must be directed solely towards peaceful ends. He refutes false theories based on an over-simplified interpretation of science (the legitimacy of human selection, for example). He defends science, saying that each failure has been followed by a new leap forward, and ends by expressing the hope—which was shared by so many people—that the war would lead to the liberation of peoples and to permanent peace.

COLLECTIVE AND ANONYMOUS WORKS

748 *La fin du monde ou l'âge d'or.* Histoire documentée de l'énergie atomique. Paris, Braun et Cie., 1946. 4to, 51 pp.
An illustrated booklet, designed for the general public, containing sections on the following: From the philosopher's stone to Hiroshima; The trail-blazers (Lavoisier, Dalton, Ampère); The prophets (Robida, Jules Verne, H. G. Wells); The conquest of the atom (Einstein and other contemporary scientists); Raw materials; Atomic explosions—political and other consequences.

SCIENCE AND THE HUMAN PERSON

749 ALLENDY, René. *La psychanalyse, doctrine et applications.* Paris, Ed. Denoël et Steele, 1931. 16mo, 248 pp.
An account of the work done by Freud and his school. This book, which is intended for laymen, emphasizes the practical value of psycho-analysis and the great importance of the facts which it has revealed.

750 BIOT, René. *Offensives biologiques contre la personne.* Paris, Éditions Spes, 1950. 16mo, 192 pp.
The rapid development of the biological sciences is giving modern man ever-increasing power. Eugenics and narco-analysis are the two most salient features of this process, but they tend to rob man of his personality and therefore constitute a grave menace to him—a menace it is imperative to denounce before it is too late. Dr. Biot considers, in the various fields, the ways in which modern biology may affect man; he shows its dangers and defines the limits which should not be overstepped. In this respect, he recalls the attitude and instructions of the Vatican, which he approves. He then examines, in turn, morpho-endocrinology, the biochemical interpretation of moral states of mind, the limits placed upon individual liberty by preventive medicine, experimentation upon man, psycho-surgery, problems of tests and guidance, psycho-analysis, eugenics and artificial fecundation. Every discovery involves risks; but medicine, both as a science and as a technique, must respect and serve the human person and the spiritual needs of man, regardless of social requirements.

751 BONNARDEL, R. *L'adaptation de l'homme à son métier.* "*Bibliothèque de philosophie contemporaine*". Paris, Presses Universitaires de France, 1943. 204 pp.
A brief but complete and well-documented statement of the principles of psycho-technics, which should enable man to be adapted to his calling, and vice versa. A criticism of the traditional methods of professional selection. A statement of the main doctrines current in psycho-technics, and more particularly of the "structural experimental tendency" (factorial analysis), which enables man's gifts and potentialities to be analysed more rationally.

752 BOREL, E. *Le jeu, la chance et les théories scientifiques modernes.* Collection "*L'avenir de la science*". Paris, Gallimard, 1951. 8vo, 224 pp.
The purpose of this work is to describe the basic principles of the science of chance and the unity of its methods, despite the very different ways in which it is applied. After briefly listing the various kinds of game, the author sets out to show the close relationship between games of chance and the theory of probabilities, with the object of combating, through his conclusions, the preconceived views generally existing with regard to this problem.

753 BOREL, Emile. *Les probabilités et la vie.* Collection "*Que sais-je?*". Paris, Presses Universitaires de France, 1950. 16mo, 120 pp.
Study of the application of the mathematics of probability to a certain number of questions bearing on daily life, sickness and death. The first chapter deals with the relationship between the mathematics of probability and the psychology of gamblers, the second with the difficulties that arise as soon as the probabilities relate to human life. The author then tries to establish which "probability values" are virtually negligible, and so to define the probabilities that are negligible at the human, world, cosmic and super-cosmic levels. There follows a number of comments on the definition of probabilities in everyday life. Chapter IV contains a study on occurrences whose probability is very slight, though no longer wholly negligible when the number of "positive tests" is very high. Thus we see that it is possible to deduce, from the single law of chance, a law which is most useful in practice—Poisson's law. In a few paragraphs the probabilities in respect of decease (already discussed in Chapter II) and of sickness and accidents are studied in greater detail. The last chapter deals with some curious forms in which the mathematics of probability are applied to certain problems bearing on heredity in the human species. The work ends with three notes, and tables.

754 CABANES, Dr. *Chirurgiens et blessés à travers l'histoire.* Des origines à la Croix-Rouge. Paris, Albin Michel. 624 pp., 275 plates.
Often, in armies, more men have been killed by epidemics than in battles; but the more murderous wars become, the more successfully do medical techniques save the wounded.
The soldier is no longer a mercenary; it is now recognized that a wounded soldier, even an enemy one, must be recovered and given proper attention. It is this humanitarian idea that gave rise to the International Red Cross.

755 CARREL, Dr. Alexis. *L'homme, cet inconnu.* Paris, Plon, 1935. 8vo, 400 pp.
An attempt to give a comprehensive picture of what we know about the physical and psychological functions of man. The present body of scientific data shows that the decline of civilization and the degeneration of the individual are attributable to a misunderstanding of the proper relationship between man and the world, between the mind and the body. With a better understanding, and with the development of the sciences of life, it would be possible to overthrow the industrial civilization which is the root of all our troubles and to introduce a new conception of human progress. The writer does not shrink from any of the conclusions suggested to him by this new "science of man": a return to the system of the small craftsman, the relegation of women to the home and "woman's work" alone, the killing of lunatics and criminals, etc. This book, which was printed in a very large edition, has had an appreciable influence on a certain section of the French public.

756 CHAMPY, Paul. "La lutte de la biologie contre la vieillesse". "*Almanach des sciences*", 1949. Paris.

Editions de Flore et Gazette des Lettres, 1949. 16mo, 256 pp.

Reflexions on the phenomenon of ageing in animal biology and on the experiments being made with sexual hormones in therapeutics. Hopes of prolonging life, and the social consequences that would ensue from such prolongation.

757 CHAUCHARD, Paul. *La mort.* Collection *"Que sais-je?"*. Paris, Presses Universitaires de France, 1947. 134 pp., bibl.

The first part of this book deals with the death of the living cell; the second and more important part concerns the death of higher organisms, the struggle against death, diseases, and the problem of ageing.

The author refrains from advancing any hazardous theory on a subject in which science and philosophy are alike involved.

In the light of our biological knowledge, it seems that death, which is inescapable, might be retarded if the best possible conditions were created. (The present limit of longevity seems to be 115-120 years.)

758 COIGNY, R. L. "Service de santé", in the review *Chemins du monde: personnes déplacées.* Paris, Editions de Clermont, 1948.

An account of the work done, under the auspices of Unrra, by the health service in the displaced persons' camps in Germany. In 1945, Europe was spared epidemics thanks to the progress made, since the beginning of the century, in preventive and curative medicine. Social problem of refugee members of the medical profession.

759 GAUDUCHEAU, Dr. A. *Le sort de Prométhée,* a note on the origins and biological consequences of discoveries, presented to the Société de pathologie exotique on 14 June 1944. Laval, Imprimerie Barnéoud. 8vo, 48 pp., bibl.

Brief notes on some of the consequences of hygiene and of food variety in human societies, especially among certain peoples in the French colonies (Madagascar, Indo-China).

760 HALDANE, J. B. S. "La génétique humaine et l'idéal humain", in *Le progrès scientifique* by Sir James JEANS, Sir William BRAGG, Professor HALDANE, etc. Translated from the English by Paul Couderc. Paris, Félix Alcan, 1938. 8vo, 198 pp.

The problem of eugenics. Integral eugenics will remain inapplicable, unless and until there is a radical change in our ethical code. As for sterilization, though some have regarded it as a panacea, the author considers that, for the moment, it is inseparable from class reactions (Great Britain) or even from the urge to destroy (Nazi Germany). Reservations concerning voluntary sterilization (British experiment). Problem of racial cross-breeding. The author concludes that, while extreme ideas should be rejected, certain eugenic measures are none the less desirable.

761 HEUYER, Georges. *Narco-analyse et narco-diagnostic.* Leur emploi en médecine légale. Histoire d'un procès. Paris, L'expansion scientifique française, 1949. 8vo, 96 pp., bibl.

Pentothal and individual liberty. This book is an echo of the N... Case (1946), which deeply stirred and divided public opinion. In an introduction the author recalls the nature of narco-analysis and gives an historical account of it. He distinguishes it from narco-diagnosis, the use of which seems legitimate in so far as it is intended to be therapeutic and not merely penal. He records the hope that narco-analysis will one day be used to determine the psychological condition of the criminal, the latter consenting to it as it might be to his advantage. Consequently, it is necessary to establish legal rules concerning the use of the "truth serum".

762 LAMIRAND, Georges. *Le rôle social de l'ingénieur.* Prefaced by a letter written by Marshall LYAUTEY. Foreword by Léon GUILLET. Member of the French Institute. *"Editions de la Revue des Jeunes".* Paris, Desclée et Cie, 1932. 16mo, 251 pp.

The engineer's profession, conceived and practised as a "mission". Study of the engineer's role in the factory and in social life. A man of action and of achievement, occupying a key position in the modern world, he must be equal to the social responsibilities which will henceforth fall upon him, and should seek rather than evade them.

763 LE GUILLANT, Dr. L. "Objet et Méthode de la Neuro-Psychiatrie infantile", *L'Evolution Psychiatrique.* Paris, Fasc. III, Oct.-Dec., 1948. pp. 95-133.

Child neuro-psychiatry forms part of what is called extended psychiatry. Is it right that the psychiatrist should deal with problems that are generally of a social nature? His role is justified, for he is the person most qualified to study a field in which biology, pathology, psychology and pedagogy are intermingled. But the psychiatrist must regard his role as simply that of an orchestral conductor, and must not claim the right to impose views that are based on pathology alone.

764 LERICHE, René. "Pour une renaissance de la recherche chirurgicale en France", *Médecine de France,* No. 4. Paris, Olivier Perrin, 46 pp.

A rough outline of a programme of surgical research and organization designed to achieve the maximum efficacy; it must be placed on a hospital basis, for, as specialization is increasingly becoming not only the rule but a pre-requisite of progress, there must be ever closer co-operation between doctors and surgeons.

765 LERICHE, René. *La chirurgie, discipline de la connaissance.* Facsimile of an extract from a letter written by Henri Bergson. Preface by Georges DUHAMEL. Afterword by François Joachim BEER: notes on René Leriche. Nice, La Diane française, 1949. 8 vo, 509 pp.

Surgery, a human adventure. This book contains a large number of texts, one of the most important being that entitled *De l'humanisme en chirurgie* (Humanism in Surgery). Humanism is the ethical code which, for the surgeon, defines the limits of his rights and the extent of his duties. Since man, as an individual, must serve not only as the "measure" but also as the "end" of surgery, the surgeon's desire to heal must outweigh his desire for technical perfection. This work also contains a note on the social danger which would be created by a lowering of the intellectual and moral standard of the medical profession, which is possible owing to the spread of officialdom. Reference to Thierry de Martel. Series of portraits and souvenirs.

766 LOURBET, Jacques, *L'expérimentation biologique, "Bibliothèque de philosophie sociale".* Saint-Girons, Ariège, 1928. 8vo, 29 pp.

A small pamphlet against the immunizing of new-born children by means of BCG vaccine. In the preface, the author departs from his strict subject and considers the possible consequences, from a social standpoint, of according too much liberty to experimental medicine. He then criticizes, on a scientific basis, the method at issue and arrives at the conclusion that the sole remedy lies in improving the environment.

767 MELLANBY, E. "Progrès dans les sciences médicales" in *Le Progrès Scientifique,* by Sir James JEANS, Sir William BRAGG, etc. Translated from the English by Paul Couderc. Paris, Félix Alcan, 1938. 8vo, 198 pp.

The alternation of progress and obscurantism in the history of the medical sciences. The study of diseases and of the means of combating them has always deeply interested the human race. The Greek attitude, which is now adopted by the whole of the civilized world, and which regards physical health and harmony as of great value, has resulted in a great increase of medical research. Personal hygiene and cleanliness, sanitary organization, and closer and simpler relations between the medical profession and the public have largely contributed during the past 50 years to a general lowering of the death rate, and especially of infant mortality. Statistics and graphs.

768 PEQUINOT, Dr. Henri. "Le rapport Kinsey vu par un médecin", *Médecine de France,* No. 5. Paris, Olivier Perrin, 47 pp.

Analysis of the Kinsey report [*Le comportement sexuel de l'homme* ("The sexual behaviour of man"), by A. Kinsey, translated from the English. Paris, Editions du Pavois, 1948. 16mo, 1022 pp.]. The report provides a lesson in scientific methodology, owing to its use of statistical analysis and the method of public opinion polls, as well as its study of border-line cases. This work shows the man of action that the principles guiding his life lack a biological basis and suggest to him an organization of society that is out of harmony with realities. Moreover, it opens up a new path for moralists—the path of efficiency.

769 PORTES, L. "Médecine et euthanasie", *Médecine de France*, No. 6. Paris, Olivier Perrin, 46 pp.
An impartial presentation of the question. This article contains numerous examples and quotations taken from the fields of medecine, philosophy and law. In the last part, euthanasia is considered from its strictly medical aspect. Difficulties of making an infallible diagnosis. Advantages and dangers of the method.

770 ROGER, H. *Eléments de psychophysiologie.* Paris, Masson, 1946, 428 pp.
After describing the history of psychophysiology, the author considers the means of investigation now at psychologists' disposal. Chapters on the evolution and externalization of psychophysiology, followed by a discussion on the question of determinism and free-will in the light of the most recent developments in science.

771 ROSTAND, Jean. *La biologie et l'avenir humain.* Uchronie scientifique. Collection Descartes *"Pour la vérité"*. Paris, Albin Michel, 1950. 16mo, 94 pp.
An account of biology's new achievements, its ambitions and its immense possibiilities. The resulting prospects for the human race. Although humanity can already, to a large extent, control its own organic destiny, the social conscience of 1950 resolutely rejects the brutal selective methods recommended by a type of genetics freed from all sentimental or moral prejudices. The problem raised is a purely ethical one. Despite these restrictions, biology, which is resolved to exert an influence on our manner of living and procreating, is preparing to change our way of life as well as our customs.

772 SUTTER, Jean. *L'eugénique.* Problèmes, méthodes, résultats. Preface by Alfred SAUVY. Institut National démographique. Paris, Presses Universitaires de France, 1950. 8vo, 246 pp.
An estimate of achievements in the field of eugenics during the last few decades. This important work, which it is difficult to sum up in a few lines, consists of three main parts, describing the scientific notions on which eugenics are based, the main results they have achieved, and some of the immediate problems raised by the latest developments in this field.

773 WALLON, Henri. *Psychologie et psychotechnique.* Conférences de l'institut supérieur ouvrier, série culture générale IV. Paris, C.C.E.O., 1937. 31 pp.
A statement of the principles of psychological science, which has so long been at issue with the experimental sciences The tests are the results of precise needs. Towards 1900, when competition in industry became keener, psycho-technics and the rationalization of work made their appearance. Criticism of Taylorism, as being based solely on increased productivity, without regard for the rhythm of work peculiar to each individual, man being treated as a "natural force".
On the other hand, psycho-technics, if properly used, can be instrumental in improving labour conditions. The originality of this science is that it was established simply to meet practical needs, and that it takes technique as its starting-point.

774 WELLS, H. G. "La santé dans l'avenir". Translated by Antonina Vallentin. *Europe*, August 1938, No. 188, pp. 483-93.
This great writer forecasts, in his imagination, what science will be able to do for man when the necessary changes have been made in a world that is constantly a prey to crises which hinder progress.
The old type of medical practitioner will cease to exist; medicine will take the offensive and suppress disease by destroying microbes, by improving food, etc.; man will become taller and more attractive physically, will live longer, and will always be good-humoured.

SCIENCE AND CULTURE

775 BAUER, Edmond. "Rapports entre la physique actuelle et la philosophie", in *Evolution de la physique et de la philosophie.* Quatrième semaine internationale de synthèse. Paris, Félix Alcan, 1935. 8vo, 150 pp.
The aim of this paper is defined in its title. Taking as a basis the most recent problems connected with the relativity and quantum theories, it analyses the close relationship between science and philosophy; the theory of knowledge, on which all philosophy is now based, amounts to reflexion on the methods and results of the positive sciences.

776 BAYET, Albert. *La morale scientifique, essai sur les applications morales des sciences sociologiques.* Paris, Félix Alcan, 1905. 16mo, 180 pp.
Ethics is an objective science which must consider acts as "things", but with the development of sociology and the science of social behaviour, it will be possible to build up a rational technique of ethics capable of effectively influencing moral behaviour. The work under consideration sets out to determine the bearing on ethics of the science of social behaviour and of the sociological sciences. Its interest is chiefly historical.

777 BAYET, Albert. *La morale de la science. "Bibliothèque rationaliste".* Paris, Société des Editions Rationalistes, 1947. 16mo, 159 pp.
Research on the influence of science in the sphere of ethics. The argument is the same as in the preceding work (*morale scientifique*) but enhanced by the experience gained from 1940-45 and by the experiments made with the atomic bomb.

778 BAYET, Albert. *Les rapports de la science et de la morale.* Sorbonne lectures for the Certificat d'Etudes Supérieures de sociologie. Paris, Tournier et Constans, 1943. 4 vols. 4to, typed.
Lectures given at the Sorbonne, 1932-33. Science, which never lays down standards, cannot serve as the basis of any system of ethics; it records facts without passing any judgment on them. But since its existence presupposes the application of moral laws, some system of ethics must underlie all scientific creation. Importance of intellectual achievement as the disinterested pursuit of truth.

779 BERTHELOT, Marcelin. *Science et morale.* Paris, Calmann Lévy, 1897. 8vo, 515 pp.
Collection of articles and speeches on the general purpose of science and its bearing on ethics and education. The ancient crafts handed down from the Middle Ages, Arab chemistry, assistance to agriculture, Papin, and the invention of the steam engine, etc. In the preface to his book, Mr. Berthelot expounds certain views on the changes which science is bringing about in human societies, and remarks that one of the first effects of scientific observation and experiment will be to overthrow the empirical and fatalistic idea of progress. Social and economic evolution is the rational outcome of laboratory discoveries of facts and laws: it will go hand in hand with moral belief in the interdependence of the entire universe. The golden age will dawn if we abide by the teachings of science.

780 BLANCHÉ, Robert. *La science physique et la réalité.* Realism, positivism, mathematics. *"Bibliothèque de*

Philosophie contemporaine". Paris, Presses Universitaires de France, 1948, 8vo, 213 pp.
Philosophical work intended for specialists. The author discusses the apparent connexion, in modern thought, between the development of physics and of idealist philosophy.

781 BOLL, Marcel. *L'occultisme devant la science.* Collection *"Que sais-je?"*. Paris, Presses Universitaires de France, 3rd edition, 1950. 136 pp., tables, bibliographical notes.
A systematic critical study of various forms of occultism (astrology, divining, sympathetic magic, telepathy, etc.), none of which can stand the test of serious scientific examination. Throughout this short study, founded on a great collection of precise data but tending to be polemical in tone, the author repeatedly draws attention to the disastrous influence exercised by occultists on weak and naïve people, especially in times of upheaval.

782 BOLL, Marcel and André. *L'élite de demain.* Collection *"Science et humanité"*. Paris, Calmann Lévy, 1946. 16mo, 329 pp.
Calls for disinterested culture to be put at the service of mankind. Presents a critical analysis of the causes of the crisis through which society is passing—the incoherent exploitation of the applied sciences, the failure to realize the possibilities of social science, and the breakdown of traditional leadership—and discusses the conditions in which that crisis could be overcome. There is a need to rouse public opinion and guide it towards disinterested preparation for the future. Salvation can come only from the highest level, by means of scientific education and the training of character, by a stringent choice of really outstanding leaders from all sections of society and free of all political or financial pressure. A number of problems connected with instruction, the dissemination of science, active methods in education, etc. are given detailed consideration in a chapter which deals with this training of new leaders.

783 BOREL, Emile and CHÉRON, André. *Théorie mathématique du bridge à la portée de tous.* No. V in the series of monographs on probability. Paris, Gauthier-Villars, 1940. 25×17 cm., 392 pp.
Description of the problems of probability met with in bridge at various stages in the game. This work will be of particular interest to mathematicians, who will find in it inexhaustible matter for practical experiment. It will also be of service to players. Even if the latter cannot observe all the mathematics of probability, they will be able to assess the soundness or otherwise of the established principles of the game, and correct them as opportunity arises.

784 BRÉHIER, Emile. *Science et humanisme.* Foreword by Henri BERR. Paris, Albin Michel, 1947. 16mo, 61 pp.
Study of science and humanism regarded as values. History of their points of contact and differences. The author concludes that science has a "spiritual value", but that since its action is governed by no intrinsic law, it must be subordinate to humanism.

785 CACHIN, Marcel. *Science et religion.* Editions Sociales, 64 bd. Auguste Blanqui, 1946. 62 pp.
Discussion of the relationships between science and religion, viewed from the Marxist standpoint. Science has always been the enemy of religion, which it has had to combat in order to develop. Materialist scientists are gaining a mastery over nature: they have an aim and an ideal. But they do not disregard religious thought, which has been and still remains a branch of thought.

786 CORCOS, Fernand. *Bilan de la vie. Limites à l'homme.* Quebec, Canada, Editions Marquis-Montmagny, 1944. 16mo, 186 pp.
Man's position in the modern world. After expressing the hope that humanity will free itself from war and discover the right road to social progress, the author considers various prospects opened up to man by the most recent scientific discoveries. The last part contains philosophical considerations on the problem of the supernatural.

787 DURRLEMAN, Valdo. "Science et foi". *La Cause*, Nos. 5-6-7, May-June-July, 1942. 52 pp.
(1) Science as the servant of faith; the true scientist must needs be an idealist.
(2) The Christian faith as the prop of science, without which, indeed, the scientist would find no ultimate aim for his work.
(3) Protestantism, through its spirit of free enquiry, has given a special impetus to science.

788 ELBE, Louis. *La crise morale devant la science moderne.* Paris, Librairie Académique Perrin, 1937. 8vo, IV + 284 pp.
Discussion, from an unequivocally spiritualistic and Christian standpoint, of the new physical concepts concerning the gradual attrition of matter and energy, and their repercussions on our idea of the world.

789 FERRIÈRE, A. *La science et la foi.* Introduction by Théodore FLOURNOY. Neuchâtel, Delachaux et Niestlé, S.A., 1912. 16mo, 65 pp.
A short dissertation. The author shows that science is not and cannot be a doctrine. It is a method. The essential characteristic of science is that it is always in a state of development, never complete. Neither is religion a doctrine; it is first and foremost a moral aspiration, to which the various dogmas, themselves necessarily impermanent, give a merely symbolic expression. This being so, there can be no conflict between science and religious belief. On the contrary, as the future will show, religious faith and the scientific spirit are closely associated in the greatest men.

790 FIOLLE, Jean. *Science et scientisme.* Paris, Mercure de France, 1936. 16mo, 264 pp.
Critical essay. The scientific dogmatism of Haeckel and Berthelot is now out-dated. Yet there are signs of a "neo-scientism" which, by acting on the genuinely scientific outlook, to some extent affects humanity's future. The author takes up a definite position; while admitting that scientific evolution cannot be pre-judged, since it must in the last resort depend on the form taken by future societies, he is concerned to warn public opinion against the dangers of a new "religion of science".

791 FLERS, Robert de. *Le sentiment religieux et la science.* Enquiry addressed to members of the Académie des Sciences. Paris, Spes, 1928. 8vo, 160 pp.
The enquiry which was published in *Figaro* between 2 and 25 May 1926 was a response to the question "Does science rule out religious feeling?" Some 50 replies are given in the book, including those from A. d'Arsonval, E. Borel, E. Branly, M. de Broglie, G. Claude, Field-Marshal Foch, de Launay, J. Perrin and E. Picard.

792 FLORISOONE, Michel. *Aperçus sur certains rapports de la science et de l'art.* Lectures at the Palais de la Découverte. Paris, June 1948, 16mo, 23 pp.
Essay on the points of contact between science and art. The author shows the close relationship between the development of science and that of art. This theory is supported by numerous examples, which point to the decisive role played by the various branches of science in renewing forms of art.

793 GIRET, André. *La science et le scepticisme religieux.* Introduction by Léon GUILLET. *"Philosophie et problèmes contemporains"*. Montreal, Fides, 1947. 8vo, 146 pp.
Aims at re-establishing the idea of God in contemporary scientific thought. Denounces the evils which have resulted from the doctrines of atheism (the Encyclopaedists) and from theories such as positivism, evolutionism, monism and scientism. Science will come safely through the phase of religious scepticism, not only because—as has been demonstrated by the writings of J. B. Dumas, Bergson, Pasteur, de Lapparent and others—there is no antithesis between science and religion, but also, and more especially, because religious feeling will inevitably help to pave the way for scientific research.

794 GLEIZES, Albert. *Art et science.* Isère, Editions Moly-Sabata-Sablons, 1933, 8vo, 109 pp.

This work draws a parallel between the development of the arts and that of science since the nineteenth century. It is based not only on the author's own personal experience, but on the ways in which artistic and scientific works resemble one another. Physicists, mathematicians and astronomers are quoted in support of this view, which emphasizes the human mission that is common to both artists and scientists.

795 GOGUEL, Jean. *L'homme dans l'univers.* Collection *"Les grandes découvertes scientifiques"*. Paris, Corréa, 16mo, 256 pp.
Important essay on man's position in the universe. The author deals in turn with geometric space, the basic elements of matter, solid bodies and statistical phenomena, especially as regards thermodynamics, the world of astronomy, the globe, life and the human species. In the last 50 pages, beginning with the chapter bearing the significant title "Humanity perplexed", the author deals with religious and philosophical considerations. His conclusion is a very pessimistic one: the world offers so many contradictions that no pre-established plan can be found in it. Man should seek to develop himself intellectually and artistically; that is the most reasonable ideal he can set himself. He will never escape the acute conflict within him between "his love of life and the certainty of death". For J. Goguel, religion plays a secondary role although it may be useful in so far as it helps to calm anxiety or fear.

796 GURVITCH, Georges. *Morale théorique et science des mœurs*, leurs possibilités, leurs conditions. *"Nouvelle encyclopédie scientifique"*. Paris, Presses Universitaires de France, 1948. 16mo.
Philosophical enquiry into the conditions for theoretical ethics and the science of social behaviour. Importance of Lévy-Brühl's work. Discussion of historical antecedents beginning with Pascal. The conclusion reached in this systematic description of progress in the study of ethics is that there is a relationship between theoretical ethics and the science of social behaviour, neither of which can progress without the other.

797 HALDANE, J. B. S. "L'homme dans l'univers au regard d'un savant" in *Rencontres internationales de Genève 1949: Pour un nouvel humanisme.* Neuchâtel, Editions de la Baconnière. pp. 137-58.
Haldane concludes his address as follows: "I have tried to show that the natural sciences can and must be an important constituent element in any new humanism. I feel sure that any attempt to introduce a humanism taking no account of scientific data and the attitude of research workers is doomed to failure."

798 HASLETT, A. W. *Les problèmes non résolus de la science.* Translated by J. Buhot and J. Rossignol. Paris, Hermann Ed., 1938. 349 pp. Index.
A survey allowing of an assessment of progress and an understanding of the march of science.
The aim is not merely to understand Nature, to gain insight into its secrets and to improve on its achievements: Man reaches out beyond Nature.

799 HOURTICQ, Louis. *L'art et la science. "Bibliothèque de philosophie scientifique"*. Paris, Flammarion, 1943. 16mo, 243 pp.
Historical analysis of the mastery of facts by art and science from earliest times. There has been a parallel progress in both these spheres of human activity, but art has almost invariably been ahead of science. The author shows throughout that art is actually an interpretation, the application of some kind of provisional science or a tentative world philosophy. For instance, building means the application of the laws of mechanics before they are known, sculpture implies a knowledge of anatomy, and so on. The book deals with the visual arts only and takes most of its examples from Western civilizations.

800 JEANS, Sir James. "L'homme et l'univers", in *Le progrès scientifique* by Sir James JEANS, Sir William BRAGG, etc. Translated from the English by Paul Couderc. Paris, Félix Alcan, 1938. 8vo, 198 pp.
Man, and his reflexion in the ever-changing mirror of his knowledge. From the speculations of the ancients, the tyranny of superstition and magic, up to the Theory of Relativity which abolishes all definite distinction between space and time, Man's ideas regarding himself and the universe have been constantly altering. Outlining the general history of the problem, the author demonstrates that, until the last few years at any rate, scientific knowledge has been steadily forcing Man to greater humility regarding his own position in the universe. However, in the light of recent knowledge, resulting from the relativity and quantum theories, Man seems justified in taking a more optimistic view of his situation than was possible, for instance, in the Victorian scientific era. There is no longer any ground for denying all progress or all distinction between good and evil. The common-sense Man wishes to decide along what lines he will develop and, within certain limits, to carve out his own future: and this attitude is undoubtedly the best.

801 LALO, Ch. "L'idée de progrès dans les sciences et dans les arts". *Journal de psychologie normale et pathologique.* Paris, Félix Alcan, 1930. 8vo, pp. 449-84.
This is an interesting comparative study of the concomitant evolution of the sciences and arts; it shows how this evolution helps to elucidate the idea of progress. After disposing of certain inadequate definitions, the author develops his own ideas on this question in three very interesting chapters: progress by growth; progress by adaptation; and progress by mutation. He shows the special historical conditions conducive to any important discovery, and the extent to which such discovery leads the way to new forms of thought and perception. His conclusion is that the idea of progress has an objective value and a usefulness from the methodological point of view, both in the sciences and in the arts.

802 LANGEVIN, Paul. "Contribution de l'enseignement des sciences physiques à la culture générale", in *Paul Langevin, la pensée et l'action.* Preface by Frédéric JOLIOT-CURIE and Georges COGNIOT. Paris, Les Editeurs français réunis, 1950. 16mo, pp. 212-36.
The problem of planning scientific studies. How to adapt teaching to pupils of all ages for maximum educational value. Criticism of science teaching in 1931. Proposed remedies. Need for striking a balance between the scientific, the historical and the philosophical approach.

803 LANGEVIN, Paul. "La valeur éducative de l'histoire des sciences", *Bulletin de la société française de pédagogie*, No. 22, December 1926.
Study of the distortion that dogma introduces into the teaching of science. The importance of a return to the sources both as regards history and for practical work (laboratory work and manipulations). The danger of the growth of esoteric forms through over-hasty generalization; in mechanics and dynamics alone, there are recent examples in the true line of magic, astrology and scholasticism. No teaching worthy of the name can afford to neglect the history of ideas.

804 LAPIE, Paul. "Morale et science", in *Morale et science.* Collection of lectures by MM. LAPIE, PARODI, MELINAND, and others. Foreword by M. LAPIE. Paris, Librairie classique Fernand Nathan, 1923. 16mo, 222 pp.
The interdependence of science and ethics. Our ethical doctrine is based on a firm principle, that of justice, which, after all, may be called a corollary of the principle of causality, the basic principle of science. Ethics may thus share the acceptance accorded to science by the human mind and become truly universal.

805 LECŒUR, Charles. La sociologie dans le contact des civilisations au Maroc, in *Les convergences des sciences sociales et de l'esprit international.* Records of the International Conference on Social Sciences, Paris, July 1937. Paris, Paul Hartmann, 1937. pp. 290-99.
A discussion, in relation to Morocco, of the part that can be played by sociology in clashes between different civilizations. There is a close relationship between sociological understanding and the attitude of opposing groups. Sociological understanding, by permeating the group studied, gradually manages to make it change its own idea of its customs, and finally brings about their

disappearance. The author, who is the Director of the *Institut des Hautes Etudes Marocaines* in Rabat, mentions several specific, practical examples drawn from his personal experience.

806 LURQUIN, Constant. "Science et culture", paper presented to the Congress of the Association française pour l'avancement des sciences. *Sciences*, Bulletin of the Association pour l'avancement des sciences, Paris. No. 61, Jan.-Feb.-March 1949. pp. 81-85.
A tribute to the work of the *Association française pour l'avancement des sciences*, which provides a meeting-ground for scientists in every branch of knowledge and thus militates against narrow specialization, the inevitable outcome of scientific advances.
A reasonable standard of general culture, not to be confused with encyclopaedic knowledge (meaning a smattering of everything), is an essential part of the scientist's make-up.

807 MAURIAC, Pierre. *La médecine et l'intelligence* (1840-1940). Bordeaux, Delmas, 1949. 272 pp.
Medicine has had a great influence on writers, and less on philosophers. Strangely enough, artists and—even more strange—physicists and chemists have been practically unaffected by medicine (Pasteur being a splendid exception).

808 MOCHI, Alberto. *Science et morale dans les problèmes sociaux*. Paris, Félix Alcan, 1931. 8vo, 582 pp.
This work, which concludes the author's studies on the pure and applied sciences, is an illustration of the scientific method as applied to social problems. He stresses the preponderant influence exercised by the various branches of science on the evolution of sociology.

809 MONDOR, Henri. *Pasteur*. Paris, Corréa, 1945. 16mo, 191 pp., plates, portraits.
Pasteur's tremendous personal influence on biological science. Account of his personal life and development of his scientific genius. Pasteur's greatest triumph was in the humanitarian field, as the saviour of industry and of human life.

810 MONOD-HERZEN, Edouard. *Science et esthétique*. Paris, Gauthier-Villars, 1925. 8vo, 16 pp.
A short treatise which draws a parallel between the spheres of the scientist and those of the artist. These spheres, so far from conflicting, involve research culminating in "dovetailed" results: science and art are simply two separated facets of a series of activities (mathematics, physics, biology, psychology, aesthetics) in which the role of quantity gradually decreases and that of quality progressively increases. Both are of equal importance in the general problem of knowledge.

811 MONTEL, Paul. *"L'art et les mathématiques"*, *Sciences*, Record of the Association française pour l'avancement des sciences, Paris. No. 61, Jan.-Feb.-March 1949, pp. 61-80.
Artists are obliged to conform to natural laws: things are beautiful only in so far as they are within the scope of human apprehension.
Documented account of relationship between works of literature and art and mathematics (rhythm, geometrical relationship, etc.).

812 PAUCOT, René. *Le rôle des sciences dans l'éducation*. Paris, A. Colin, 1920. 16mo, 259 pp.
The sciences in education in France after the world war of 1914-1918. This book, which was provoked by the controversies between those who upheld the humanities and those who wished to develop science curricula, analyses the part played by the physical and natural sciences in the intellectual development of the child, and in the training of its imagination, taste and moral habits.

813 PELSENEER, Jean. *L'évolution de la notion de phénomène physique*, from the primitives to Louis de Broglie and Bohr. Office International de Librairie, 184, rue de l'Hôtel des Monnaies, Brussels. 178 pp., Index.
Lessons by Pelseneer on the history of scientific thought with special reference to the repercussions of scientific progress on the development of scientific concepts, e.g. "Law", "Objectivity", both fundamentally modified by the advance of modern physics.

814 POINCARÉ, Henri. *La valeur de la science. "Bibliothèque de philosophie scientifique"*. Paris, Flammarion, 1906. 12mo, 276 pp.
Aspects of the mathematical and physical sciences illustrative of the objective value of science. In an introduction Poincaré defines the aim of human activity as the search for truth—moral as well as scientific, the two types being indistinguishable in so far as they presuppose an identical effort to transcend prejudices and passion and the same absolute honesty.

815 POINCARÉ, Lucien. *Education, science, patrie, "Bibliothèque de philosophie scientifique"*. Paris, Flammarion, 1926. 248 pp.
The greater part of this work consists of addresses delivered on various University occasions. The second part contains L. Poincaré's ideas on the role of the sciences in modern education and the ever-increasing attention that should be paid to the scientific training of young people.

816 RETTERER, E. *Religion, science et morale*. Paris, Gaston Doin et Cie, 1927. 8vo, 365 pp.
Evolution of moral and religious ideas and of science respectively. Historical outline. The author reviews contemporary knowledge of the structure and properties of living entities and seeks for the most rational explanation of variations and changes in organic forms. These phenomena in their individual aspect not only enable us to understand the history of civilization but also simultaneously illustrate what should be our behaviour to ourselves and our fellows, and enlighten us on the origin and future of things.

817 ROZWADOWSKI, Jan. *La science, la religion et l'art*. Organon, Stanislaw Michalski, Warsaw 1, 1936.
Critique of the opposition falsely postulated between science, religion and art, which are shown to be in fact merely three aspects of the relationship between Man and the world, between which no rigid line was drawn in other ages. The writer argues that any such distinction is even less possible now than then, as man's life must be planned on the basis neither of religion, nor of science, nor of art exclusively, but of the three together.

818 SAGERET, Jules. *La révolution philosophique et la science*. Paris, Félix Alcan, 1924. 16mo, 250 pp.
A comparison of contemporary philosophical ideas (Bergson, Rosny the elder, Le Dantec, Einstein), and of these with the tendencies of modern science. The object of this work is to determine in detail the nature of the philosophical revolution, what it destroys, what it leaves, and its probable consequences.

819 VANDEL, Albert. *L'homme et l'évolution. "L'avenir de la science"*. Paris, Gallimard, 1948. 16mo, 201 pp.
A synthesis of the postulates of science and philosophical thought. The author seeks to exhibit the mutual impact of Man and Evolution. The first part of his work is devoted to a study of the place and significance of Man in Evolution and the second to using knowledge of Man to clarify the process of Evolution. The author makes the point that a decisive fact in the world's history is that the evolutionary process has attained self-consciousness. Man knows that his is the crushing responsibility for the whole of future Evolution. Hence the need for balancing the conquest of matter with attention to the needs of the spirit.

820 VAN MIERLO, S. *La science, la raison et la foi. "Bibliothèque de philosophie contemporaine"*. Paris, Presses Universitaires de France, 1948. 287 pp.
All scientists feel the need for a synthesis affording a solution to ethical and spiritual problems. The conclusions of science are disputed and the ease with which they secure acceptance is in inverse proportion to the degree to which they are concerned with the problems of life and thought. The author outlines the problems he has met concurrently with his work as a

scientist and concludes that there is no conflict between reason and faith.

COLLECTIVE AND ANONYMOUS WORKS

821 *Les techniques au service de la pensée.* Lectures delivered under the auspices of the Société des anciens élèves de l'école libre des sciences politiques by P. GÉMON, P. de ROTHSCHILD, P. MORTIER and G. de TARDE. Introductions by E. de Nalèche, Paul Valéry, Marcel Prévost and S. Charléty. Paris, Félix Alcan, 1938. 263 pp.

Lectures on the press by P. Gémon, on the cinema by P. de Rothschild, and on radio by P. Mortier with a summing up by G. de Tarde under the titlé "Culture et techniques modernes" in which points made are that press, cinema and radio bulk large in our daily lives whether we like it or not; that attempts are undoubtedly made to use their powers of suggestion for propaganda and publicity; that most of the time they serve to stultify intelligence, but that nevertheless they are there, cannot be abolished and could be used to disseminate culture to the masses.

III. *Society and Science*

THE SOCIAL BACKGROUND OF INVENTION

This part covers studies of the influence of the social structure on the evolution of science, on the social background of invention and on certain problems relating to the organization of scientific research.

822 BAKER, John R. *La science et l'état planifié* (Science and the planned State). Preface by J. THIBAUD. Collection *"Civilisations"*. Librairie de Médicis, 1946. 132 pp. and index.

Science cannot be planned, for the following reasons:
(1) The satisfaction of material needs is not its sole object.
(2) Any predetermined plan is prejudicial to major scientific discoveries.
(3) Scientists must be against any type of totalitarian State.

Science must not be confused with technology, which can be planned.

823 CASANOVA, Gaston. *Mathématiques et matérialisme dialectique.* Preface by J. CHAPELON. Paris, Editions Sociales, 1946. 196 pp.

The progress of science and technology has gone hand in hand with that of mathematics. Attempts have been made to use modern mathematics as the basic for a new system of logic. Only the introduction of dialectic can convert the most abstract and impersonal of the sciences into a living science always at once definitive and with new horizons to seek. The first 12 chapters of this book are devoted to a study of the main problems of mathematics, and the last seven to criticisms of the various attempts made at a synthesis.

824 DESANTI, Jean. "La science, idéologie historiquement relative", *Science bourgeoise et science prolétarienne.* Paris, La Nouvelle Critique, 1949. 48 pp pp. 7-14.

A criticism of the notion of science as the search for truth as such. While science aims at objective knowledge of the facts, in an evolving world it is a historically relative ideology. Its role is to assimilate the heritage of the past and to eliminate what has outlived its usefulness.

825 DIEPGEN, Pr. "Les influences religieuses sur le développement de la Médecine", *Bulletin de la société française d'histoire de la médecine.* Vol. XXXII, No. 5-6, May-June 1936. pp. 136-44.

The influence of religious ideas on the scientific evolution of medicine must not be underestimated.

It is known that magical beliefs or belief in a special connexion between body and soul prevented the practice of autopsy for many centuries. Even today we find frequent instances of theories based on the notion that disease is a consequence of original sin. Be it good or bad, the influence of religion and religious ideas on medicine is a fact and cannot be left out of account.

826 DUPREEL, E. "Le passage de la religion à la science chez les premiers penseurs grecs", *Bulletin de l'institut Solvay*, Brussels, No. 24, 1913. pp. 48-52.

Essay on how science began. In the course of the transmission of Eastern religious cosmogonies there has been spontaneous elimination of fanciful elements leaving science as the psychological residue acceptable to all minds and forming an element in all assertions whatever their nature, genesis and specific value. Historical examples are given of the passage from Chaldean astrology to Greek astronomy, etc.

827 DUSTIN, *A. P.* "La médecine et le libre examen". *Revue de l'université libre de Bruxelles*, Dec. 1934-Jan. 1935, No. 2. pp. 190-213.

Medicine and astronomy are the oldest of the sciences. In medicine, however, progress has come very late, as it has suffered greatly from the intransigence of religion or the State, both of them unable to tolerate the principle

of freedom of examination without which the advance of medicine is impossible

Unhappily we cannot assume that these days are past. We still suffer from the assaults of prejudice of various types (there are still anti-vaccination leagues) and from quackery.

328 DUSTIN, A. P. *"La médecine et le libre examen". Revue de l'Université libre de Bruxelles,* Year 41, No. 1, 1935. pp. 16-57.

Research can only be carried on in an atmosphere of freedom, while in turn science is necessary to the free world. A detailed description of the qualities needed in scientists and research workers, of which the chief is perseverance to pursue a line of research when hope of tangible results is lost, and to carry it to success.

329 ENRIQUES, Federigo. *Signification de l'histoire de la pensée scientifique.* Actualités scientifiques et industrielles, No. 161. Paris, Hermann, 1934. Large 8vo, 69 pp.

A series of essays on the need for viewing science in relation to history, and on the economic, social and cultural conditions on which all scientific work must depend.

330 FRANK, Philippe. *Einstein, sa vie, son temps.* Translated from the English by André George. Paris, Albin Michel, 1950. 436 pp.

Einstein's personal story, with sketches of his various environments, anecdotes, and some account of the course of his study and work. The scientist's entry into public life after the first world war, and the reasons for the attitude he adopted. Also a psychological study of the process of scientific creation.

331 GAUTHERET, R. L. "Grandeur et servitude de la vie scientifique", *Hommes et mondes.* Paris, 1949, September, No. 10. pp. 82-105.

A statement of the limitations of science. The writer tries to show the place of the scientist in modern society. The prospects of science in France.

332 HUXLEY, Julian. *La génétique soviétique et la science mondiale.* Translated from the English by Jules Castier. Paris, Stock, 1950. 16mo, 271 pp.

Science cannot be made the servant of an ideology: a criticism of Michurinism, based on direct quotations and material published in the press. Considers the relationship between science and society in other countries and at other periods of history. The problem is how to reconcile the freedom of science with the needs of society as a whole, and to check any attempt at totalitarian regimentation of thought.

333 LABERENNE, Paul. "Le matérialisme dialectique et les sciences", in *A la lumière du marxisme,* by Jean BABY, Marcel COHEN, Georges FRIEDMANN, etc. Introduction by Dr. H. WALLON. Paris, Editions Sociales Internationales, 1935. 8vo, 312 pp. Second Part, pp. 233-61.

An attempt to "place" dialectical materialism in relation to the various systems of scientific philosophy. The whole history of modern science vindicates dialectical materialism, alike from the standpoint of the nature of its reasoning and the development of its concepts, and from that of the growing interaction of the different branches of study. The position of dialectical materialism in the U.R.S.S., the only country in the world where it is developed systematically.

334 LABERENNE, Paul. "Les mathématiques et la technique", in *A la lumière du marxisme,* by Jean BABY, Marcel COHEN, Georges FRIEDMANN, etc. Introduction by Dr. H. WALLON. Paris, Editions Sociales Internationales, 1935. 8vo, 312 pp. First Part, pp. 19-38.

An examination of the relationship between mathematics and the other branches of scientific study; problem of the relation between the development of mathematical science and life, whether in the sense of the life of the various forms of technology or of science as a whole, of industrial and economic life, or of political and social life. In connexion with mathematics, we are thus given an idea of the Marxist view of the problem of science, accompanied, by way of illustration, by a summary of the conclusions of certain Soviet scientists on the crisis in the world of mathematics at the time of the article (1933).

335 LACROIX, A. "La recherche scientifique dans les territoires d'Outre-Mer", *Thalès,* Vol. IV, 1940. pp. 13-22.

An address delivered at the Congress on Scientific Research in the French Overseas Territories. Scientific research is adversely affected by the fact that it is under the control of the Administration, which does not appreciate its full importance. This situation is prejudicial to research, as the appropriations for it may come and go with every change of government. M. Lacroix considers it desirable that the research centres should be placed under the control of some body with headquarters in Metropolitan France; this would ensure greater consistency in their operation, and make it possible to co-ordinate their work. In conclusion, he draws attention to the importance of scientific research on economic conditions in the Overseas Territories.

336 LECOMTE DU NOUY, P. "Science et laboratoire", *Revue de Paris,* June 1935. pp. 799-829.

The story of the foundation of laboratories. Little is generally known about the very special conditions in which work is actually carried on in laboratories. Disillusioned reflexions on the lack of recognition accorded to the scientist: do people consider that the scientist is a pure intellectual, finding full satisfaction—and therefore adequate reward for his labours—in research itself, or are they ignorant of the practical value of laboratory work?

337 LUMIÈRE, A. "A propos de la recherche scientifique libre ou dirigée", *Revue générale des sciences,* Vol. LIV, Series No. 2, 1947. pp. 3-6.

The author emphasizes that many research institutes, with large financial resources, highly qualified staff, and the most up-to-date equipment, have failed to come up to expectations. On the other hand, most of the great scientific discoveries have been made by scientists (who were often not even specialists) working with very meagre resources. The writer explains this paradox by the fact that most of the great discoveries destroyed the validity of previously accepted "absolute" truths and laws. The directors of research institutes have been little inclined to encourage work running counter to anything accepted as reliable scientific fact. The author quotes the case of G. Claude, who used to boast that he had paid no attention to bibliographical research: "If I had read half the articles on the subject, I should never have embarked on work which, according to them, was doomed to failure."

338 LUMIÈRE, Auguste. *Les horizons de la médecine.* Paris, Albin Michel, 1937. 8vo, 248 pp.

The second part of this book lists the various obstacles to progress in the medical field (inadequate data relating to population, misleading or defective statistics, etc.) and suggests measures for improving the position in this respect.

339 MERTON, Robert K. "La sociologie de la connaissance", in *La sociologie au XX^e siècle,* edited by Georges GURVITCH. Paris, Presses Universitaires de France, 1947. 8 vo, chap. XIII, pp. 377-416.

Method, problems, and results. An account of the more important theories on the sociology of knowledge. The essential object of the sociology of knowledge is the study of the correlation between knowledge and the other constituent factors in society and culture. Modern theories are based, in varying degrees, on the assumption that not only errors, delusions, or unfounded beliefs, but also the discovery of truth, are conditioned by society and history. With regard to scientific knowledge, these modern theories bring out, in particular, the fact that no attempt to use science or technology as the "basis" to which the social structure must be "adjusted" can be taken beyond a certain point. The Marxist theory of knowledge.

840 MIELI, Aldo. "Le réveil récent de l'étude de l'histoire des sciences et sa signification", *Scientia, Rivista de Scienza*, Vol. XVII, No. XXXIX, 1, 1915.
A discussion of the radical transformation of our conception of science, which is regarded no longer as representing an "absolute truth" to be established, but as a product of thought, and therefore relative.

841 NICOLLE, Charles. *Responsabilités de la médecine*, Vol. I (1935) First Series; Vol. II (1936) Second Series, with Jean FIOLLE, Pierre MAURIAC and Georges DUHAMEL. Paris, Félix Alcan. 8 vo, 245 pp.
Lectures delivered at the *Collège de France* during the two years preceding the death of the great scientist.
The lectures in the first series, delivered in 1934 and published in 1935, deal with the following subjects: The responsibilities of experimental medicine; The responsibilities of medicine as an instrument of civilization with regard to terminology.
Volume I also contains lectures by: Jean Fiolle on "The responsibility of the surgeon"; P. Mauriac on "Some failures on the part of medicine to fulfil its traditional functions"; G. Duhamel on "Excessive State control and the responsibilities of medicine".
The lectures in the second series, delivered in 1934, are on: Individualism in medicine; Priority questions; The disinterested scientist and the public weal; Co-operation in medicine; Major questions of conscience; The international responsibilities of medicine and doctors; The responsibilities of the Director of an experimental medical laboratory; The pointless discussion on whether or not the medical profession should stand together.

842 OLAGNIER, Paul. *Le droit des savants*. With a preface by Louis de BROGLIE. Paris, Librairie générale de droit et de jurisprudence, 1937. 130 pp.
King James I of England was the first king to grant protection to inventors, under the Statute of 1623. By the Law of 7 January 1791, the French Revolution sanctioned the patent principle, whereby inventions are treated on the same basis as property. This concept is prejudicial to the interests of scientists, who are deprived of all rights over inventions which are, to a large extent, made possible only by their discoveries.
Mr. Olagnier thinks it possible to evolve some form of legal provision defining the respective shares of invention and discovery in the profit accruing from the industrial application of inventions. The Courts would be competent to settle such disputes as would be bound to arise. The book includes a "draft Bill" prepared by the author.

843 PRENANT, Marcel. "Sciences biologiques et société", in *A la lumière du Marxisme*, by Jean BABY, Marcel COHEN, Georges FRIEDMANN, etc. Introduction by Dr. H. WALLON. Paris, Editions Sociales Internationales, 1935. 8vo, 312 pp. First Part, pp. 116-27.
Biology offers excellent scope for research on the relationship between science and social environment. The author shows, firstly, that biology is a young science, not yet very clearly defined; and secondly, quoting the classic example of the doctrine of evolution, that it is considerably influenced by social environment. Nevertheless, only when biologists find themselves under compulsion to take action—that is to say, in a classless society—are they in a position to apply the scientific method.

844 REY, Abel. "Notes sur quelques indications générales relatives à un thème d'histoire des sciences dans ses rapports avec l'histoire de la civilisation: la Révolution française et les sciences", *Thalès*, Vol. 4, 1940. pp. 56-65.
The French Revolution brought about a radical transformation in the outlook and organization of science. It destroyed the old universities, which were the home of out-worn traditions, and reorganized the colleges; it instituted "education for all" and thus made it possible to train larger numbers of scientists; and lastly, most of the scientists of the time became professors (in the past, a very unusual state of affairs).
The essence of scientific discovery is non-conformity; science is rationalist even when most empirical. The French Revolution stood for the experimental principle in science, and linked science and technology closely together. Its influence on social and humanistic studies was even more considerable (all great thinkers, economists and sociologists have invoked the scientific principles proclaimed by the Revolution). On the other hand, the influence of science on the Revolution itself should not be overlooked.

845 TRILLAT, J. *Organisation et principes de l'enseignement en U.R.S.S.: Les relations entre la science et l'industrie. "Actualités scientifiques et industrielles"* No. 67. Paris, Hermann, 1933. 3 pl. 69 pp.
In this monograph, written some time ago, the author has tried to describe not only the organization of teaching and research in the U.R.S.S., but also the principles on which scientific research there is based. Theory and practice are never separated; all scientific discoveries are directed towards practical application, with a view to improvements in the field of technology.

846 TRUNEL, Pierre. "Les méthodes de travail dans les laboratoires de recherche", *Chimie industrielle*, November 1948. pp. 489-95.
Differences between working conditions in laboratories devoted to "pure" research and those in industrial research laboratories. An account of the principles on which work in the latter is based.

847 VERNADSKY, W. "L'étude de la vie et la nouvelle physique", *Revue générale des sciences*, 31 December 1930, Vol. XLI.
A lecture containing references to a number of then (1930) recent works, the lecture being of interest mainly because of the general ideas on science set forth in it. The author's main thesis is that science is not an abstract, self-sufficing entity, but a product of human life; as such, it may be compared to a social phenomenon, leading to the scientific comprehension of the "environment".

848 WULLUS-RUDIGER, J. "La science au service de la nation et de l'humanité (la fondation universitaire et le fonds national de la recherche scientifique)", *L'Armée—La Nation*. Special number, June 1948, Brussels. 24 pp.
This special number of the magazine *L'Armée—La Nation* is entirely devoted to an historical account of the Belgian University Foundation and the National Fund for Scientific Research (FNRS). The part played by this Fund in Belgian scientific life. The FNRS was founded in 1927 as a result of an appeal launched by Albert I at Seraing.

COLLECTIVE AND ANONYMOUS WORKS

849 *"Quelles sont les qualités primordiales du chercheur"*, survey conducted by G. BOISSIÈRE for the newspaper *Le Temps* (19 July to 29 August 1938).
Replies from M. Picard, Joliot-Curie, L. Guénot, Pr. Leriche, Ch. Perez, R. A. Millikan, L. Blanrighem, P. Sabatier, L. de Broglie, Dr. Toulouse, etc.
In the final article (29 July), Mr. G. Boissière sums up the various opinions expressed and draws attention to the importance of selecting research workers with care, if science is to advance.

IV. *Documents*

This part comprises various books and articles which, whilst not dealing directly with the influence of science on society, and vice versa, constitute an essential basis for research on this subject. Most of them are serious popular studies, either on the position of contemporary science or on the history of scientific knowledge. We also give a list of the chief French reviews in which useful material for the study of the relationship between science and society is likely to be found.

850 BAUER, Edmond. *L'électromagnétisme, hier et aujourd'hui.* Collection *"Sciences d'aujourd'hui"*. Paris, Albin Michel, 1949. 16mo, 352 pp., 14 fig.
This book contains five essays: history of electrical theories; the scientific work of Coulomb; 50 years of magnetism; physics and philosophy; science and society. The fourth part (physics and philosophy) reproduces a lecture given by the author in 1933 at the fourth *Semaine internationale de synthèse*. The last part of the book discusses the inter-relationship of science and society. Social and economic conditions at any given time have a marked influence on the development of science. The converse is also true, and the major scientific revolutions have greatly influenced social life and economic development; M. Bauer mentions the Renaissance period as a striking instance, the study of which may well lead to a better understanding of the contemporary position.

851 BAVINK, Bernhard. *Conquêtes et problèmes de la science contemporaine.* Translated from the German by René Sudre (*Ergebnisse und Probleme der Naturwissenschaften*, Zürich, S. Hirzel, 1948). Part I, 437 pp., 47 fig., 2 tables.
A systematic statement of all the attainments of scientific knowledge.

852 BRUNSCHVICG, Léon. Introduction to *L'orientation actuelle des sciences.* Lectures by Jean PERRIN, P. LANGEVIN, etc. Paris, Félix Alcan, 1930. 8vo, 156 pp.
A study of the movement which has transformed the relationship between scientists and philosophers from the beginning of the nineteenth century to our time. A critique of the Positivism of Auguste Comte and of an ideal of order and harmony which amounts to a system of rules framed to meet the need for social conformity. Contrast with the ideas of Cournot, which are in advance of the modern philosophic attitude towards science, illustrated by the ideas of Emile Boutroux. Science cannot be limited by an *a priori* conception of truth. It alone is qualified to define its own limits, which are indefinitely extensible.

853 CAULLERY, Maurice. *La science française depuis le XVII^e siècle.* Paris, Armand Colin, 1933. 16mo, 214 pp., bibl.
A historic account designed to show the part played by France in the development of modern science. Conditions in which ideas and scientific achievements were spread in the seventeenth century. Scientific advances in the eighteenth century, partly due to the demands of a refined and curious society. Continuity during the Revolution, in spite of the Terror. Stages in the organization of scientific research, non-existent up to the beginning of the nineteenth century. The ideas of Auguste Comte and his definition of science. His influence. The end of the nineteenth century and the great achievements. Remarkable development of the biological sciences and of contemporary French science. The author considers that, in spite of the achievements of science, French society as a whole is not sufficiently interested in it nor sufficiently aware of its importance. He brings out certain permanent characteristics of French science: its individualistic and essentially positivist tendencies, and its humanitarian spirit.

854. CAZENAVE, Jean. *Legs de la médecine arabe à la thérapeutique française du moyen âge.* Thèse Montpellier. Algiers, Imprimerie Heinz, 1941. 175 pp., bibl.
This work is of interest because it gives particulars of the influence exercised on French medicine by Arab medical books based on the study of natural phenomena and on facts proved by experience. One chapter deals with translations. The thesis concludes with a list of plants used by the Arabs and a bibliography.

855 FAUVET, Jean. *Les étapes de la médecine.* Introduction by Professor Noel FIESSINGER. Paris, Presses Universitaires de France, 1941. 16mo, 127 pp.
This little book gives, in outline, the history of the evolution of medical science, dwelling particularly on the great epochs and presenting for each of them a statement of advances and lapses. External influences (historic events, new philosophic systems) on the evolution of medicine. Progress of medical science since 1900 and trends of contemporary medicine.

856 FILIPPI, Ulysse. *Connaissance du monde physique,* with a preface by Louis de BROGLIE. Paris, Albin Michel, 1947, 16mo, 343 pp., fig.
A work giving a comprehensive picture of our knowledge of the principles of modern physics. It is intended for the educated layman anxious to learn something of the astonishing changes physical science has undergone, and to understand the background of the atomic age.

857 JEANS, Sir James. *L'évolution des sciences physiques:* mathematics, physics and chemistry, from their earliest days to the present time. Translated from the English by René Sudre. Paris, Payot, 1950. 8vo, 318 pp., 41 fig., index.
A deliberately simplified historical account of the chief stages reached in physics and mathematics.

858 JOLIOT-CURIE, F. "Le professeur Langevin et l'effort scientifique de guerre", *La Pensée.* Paris, 24, rue Racine, No. 1, Oct.-Dec. 1944, pp. 32-37.
An account of the research undertaken during the first world war, at the request of the French Admiralty, with regard to the detection of submerged submarines. This research, like much other carried out during the war, had effects going far beyond the immediate aims in view. It drew attention to the possible uses of piezo-electric quartz, which has since served many purposes in time of peace.

859 METZGER, Hélène. *Les doctrines chimiques en France au début du XVII^e siècle.* Paris, Félix Alcan, 1923.
NEWTON, Stahl. *Boerhaave et la doctrine chimique.* Paris, Félix Alcan, 1930. 330 pp.
These two works are in sequence. The second comprises general studies on scientific developments in France in

the eighteenth century. Several pages deal with the influence of Newton's philosophy on the development of physics, and with the influence of tradition.

860 MIELI, Aldo. *La science arabe et son rôle dans l'évolution scientifique mondiale.* Leyden, E. J. Brill, 1938. 4to, 388 pp. with bibliography and index.
A general study of scientific activity in the Arab world and of its influence on the Christian world. Arab science performed the task—a basic one in the general evolution of science—of gathering together the heritage of ancient times, developing it, and communicating it to Western Europe.

861 PICARD, Emile. *La science moderne et son état actuel. "Bibliothèque de philosophie scientifique".* Paris, Flammarion, 1905. 16mo, 299 pp.
An account of the mathematical, physical and natural sciences during the first years of the twentieth century. Apart from giving an historical commentary on the development of these branches of science, the work aims chiefly at assessing methods and popularization trends.

862 PICARD, Emile. *"Les sciences mathématiques en France depuis un demi-siècle"*, in *Un demi-siècle de civilisation française.* Paris, Gauthier-Villars, 1917. 25 pp.
This record of the progress of mathematical science, made nearly 35 years ago, makes interesting reading today. Already, at the time of writing, the author was denouncing the misuse of classification and of a narrow range of symbols.

863 RANC, Albert. "L'évolution de la presse de diffusion des sciences depuis le début du XIX^e siècle", *Sciences.* Bulletin de l'Association française pour l'avancement des sciences, No. 62, April, May and June 1949. pp. 87-108.
An historical index of the chief scientific reviews in French since the days of Théophraste Renaudot, the founder of periodicals, who was the first to publish regular accounts of scientific discussions and who ma therefore be regarded as the originator of this type of specialized publication. Not until the French Revolution did science reviews begin to proliferate. In 1939 the Press Yearbook contained the names of 119 scientific periodicals and of 289 medical reviews (there being approximately 36,000 throughout the world).

864 RANSHAW, G. S. *Nouveaux exploits scientifiques.* Translated from the English. Paris, Société d'édition d'enseignement supérieur, 1948. 16 mo, 128 pp., and 36 illustrations (mostly comprised in 14 photographic plates).
A vivid account of some of the most recent achievements of scientific progress. Section headings are as follows: Penicillin, DDT, Synthetic hormones, Marine metals, Electronics, Why split the atom? The use of electrons, Proteins.

865 REY, Abel. *La science dans l'antiquité.* Five volumes: I. La science orientale avant les Grecs, 8vo, 494 pp. II. La jeunesse de la science grecque, 8vo, 537 pp. III. La maturité de la pensée scientifique en Grèce, 8vo, 575 pp. IV. L'apogée de la science technique grecque (2 volumes), 8 vo, 315 and 390 pp. Foreword by Henri BERR. Paris, Albin Michel, 1942. Bibliothèque de synthèse historique. Collection *"L'évolution de l'humanité"*. Extensive bibliography.
An important work dealing with the basic trends and theories which dominated scientific evolution in ancient times. It is worth following the main lines of the author's thought on the connexion between the development of society and that of the human mind. Knowledge has its original source in technology, which is controlled and perfected by progress in mathematics and experiment. The essence of science, even more than of technology, is individual research. It is from the individual, not from society, that an idea is born. The intellect is only "social" by reason of its consequences and, as the author says, of its "transfusion and degeneration as it spreads". All scientific progress and, more than ever today, all technical progress depend upon the intuition of the individual; and what emanates from society, as society, is merely the outcome of specific needs. The sovereign principle in scientific and technological thought must therefore be considered to be non-conformity. The prime role of logic is brought out; by "constituting" the various sciences, it determines the progress of science itself; and within that progress, it determines the progress of human thought and of thinking civilization towards "universal harmony".

866 DE ROOVER, Raymond. *Aux origines d'une technique intellectuelle; la formation et l'expansion de la comptabilité à partie double.* Paris, A. Colin, 1932. 52 pp. with bibliography.
Double-entry book-keeping was not invented in a day; it was gradually perfected as the needs of trade and finance dictated, and it is essential to them. The title of the book (*Technique intellectuelle*) is therefore an appropriate one. This short but well-documented survey describes:
(1) The origins of book-keeping.
(2) The earliest use of the double-entry system, which did not take place before the fourteenth century with its revival of commerce.
(3) The introduction of industrial book-keeping, at the time of the tremendous expansion of commerce.

867 ROSTAND, J., BOUTARIC, A. and SERGESCU, P. *Les sciences. Tableau du XX^e siècle 1900-33.* Paris, Denoël et Steele, 1933. 8vo, 498 pp. With 32 full-page plates.
A general picture, designed for the well-educated layman, of scientific activity, progress and achievement during the first 30 years of this century. The book is in three sections: P. Sergescu deals with the mathematical, J. Rostand with the biological and A. Boutaric with the physical and chemical sciences.

868 ROUSSEAU, Pierre. *Histoire de l'atome.* Paris, Arthème Fayard, 1949. 16 mo, 360 pp.
A panorama of all the work done by scientists, theoreticians and experimentalists as regards the structure of matter, investigation of the atom and its nucleus, and the revelation and use of nuclear energy, since the basic discovery of radio-activity in 1896. This tremendous enterprise throws into relief the collective and supra-national character of science.

869 ROUSSEAU, Pierre. *La conquête de la science.* Collection *"Savoir"*. Paris, Arthème Fayard, 1945. 16mo, 347 pp., illustrations, portraits.
The history, with a dated chronology and numerous illustrations, of atomic theories and of theses on the structure of matter. An inventory of the facts discovered, theses that are often contradictory, and of applications already carried out or planned—to which the author has added a number of inferences relevant to the subjects dealt with. We are thus invited to follow the evolution of pure science towards a concept of matter devoid of all mysticism and leading up to a real "symphony of science".

870 ROUSSEAU, Pierre. *Histoire de la science.* Paris, Arthème Fayard, 1945. 832 pp., bibl. index.
"We believe that science, independently of its technical results, is a social phenomenon in the same way as art, literature, law or religion; that it does not grow up in a civilization like a phenomenon apart, but that it has its roots in the social, political, economic and ideological soil of a given epoch." This is the theme underlying this book, which takes us through the history of science from its origins to the latest discoveries, while always attempting to rediscover "the link, slender though it sometimes is, which binds such and such a scientific era to its social content".

871 RUSSO, François. *Histoire de la pensée scientifique.* Ed. La Colombe, 1951. 126 pp.
The history of scientific thought from its origins to our own day. The history of sciences dominated throughout by the urge to achieve unity and synthesis.

872 SARTON, Georges. "62 revues et collections relatives à l'histoire des sciences". *Isis.* Vol. II, No. 1, 1914. pp. 132-61.

Bibliography with annotations. Mentions the following reviews: 29 German, 16 French, 6 Italian, 4 English, 2 American, 1 Belgian, 1 Russian, 1 Portuguese, 1 Danish and 1 Swedish. Notes concerning the scope, importance and origin of these publications accompany most of the references. The section relating to the history of medicine is particularly important and alone includes two reviews.

873 Sue, Pierre. *Dix ans d'applications de la radioactivité artificielle.* Preface by Professor Joliot-Curie. Paris, Société d'Editions scientifiques, 1948. 8vo, 239 pp., graphs.
Detailed account of the application of artificial radioactivity during the last 10 years in France and abroad in the fields of physical chemistry and biology. After a brief introduction concerning the techniques, methods of measurement, the results obtained and the future of the new disciplines, and a table of radio-elements and their characteristics, the author gives—and this is the main feature of the work—a long list of the activities relating to these questions, together with a brief analysis in each case. Important source of documentation.

874 Szabo, Denis. "Centres de documentation et périodiques de sciences sociales", *Bulletin de l'institut de recherches économiques et sociales*, XVI[e] année. No. 7. Nov. 1950. pp. 67-128.
A critical list of 250 periodicals throughout the world, dealing with social studies.

875 Thibaud, Jean. "Comment on domestiquera l'énergie atomique". *Almanach des sciences*, 1949. pages 9-15. Paris, Editions de Flore et de la Gazette des Lettres, 1949. 16mo. 256 pp.
Outline of the technical difficulties which must be overcome in order to establish an atomic pile and the consequences which the exploitation of atomic energy would have in the economic field increase of industrialization, domestic use of energy, development of regions at present far distant from power sources, etc.

COLLECTIVE AND ANONYMOUS WORKS

876 *Mathématiques, physique, chimie: la science, ses progrès, ses applications.* Published under the direction of Georges Urbain, Member of the French Institute, and Marcel Boll. Paris, Larousse, 1933 and 1944. 2 vols., 4to. Vol. I: 383 pp., 1,160 illustrations, 6 full-page coloured plates. Vol. II: 424 pp., 1,200 illustrations, 6 full-page coloured plates, index.
Panorama of the history of sciences, for the use of the general public. The work is divided into four parts: science up to the beginning of the nineteenth century; science during the nineteenth century; contemporary discoveries and inventions; present theoretical problems. The many reproductions of old prints alone constitute very valuable documentation.

877 *Les grands inventeurs.* Physical science and applications. Published under the direction of Louis Leprince-Ringuet. Paris, Editions d'Art Lucien Mazenod, 1950, 4to, 403 pp., illustrated with photographs in the text.
Large and well-presented volume, containing a collection of the biographies of 90 of the most famous inventors who have graced the various branches of science from Gutenberg to the present day. As far as possible, the work is divided into well-marked periods. Thus we have the period of the "Great Amateurs"; of the three branches of science which developed after the Revolution—Electromagnetism, Optics and Thermodynamics; and, finally, of Aviation and Nuclear Energy. The great development of industry in the twentieth century, on the other hand, is characterized by flashes of genius on the part of numerous inventors whom it is difficult to classify. The various chapters include introductions describing the history of the main trends in ideas and providing us with a better understanding of the psychology of the inventors in each branch. The biographies are written in very varying styles and reflect the temperaments of their authors. The work concludes with an attempt to present an historical survey designed to display a panorama of all inventions affecting physics and its application.

878 *Cinquante années de découvertes.* Bilan 1900-1950. Texts assembled by Anna and André Lejard. Paris, Ed. du Seuil, 1950. 8 vo, 350 pp.
Panorama of literature (Claude Edmonde Magny), philosophy (Jean Wahl), music and dancing (Charles Albert Reichen), arts and the cinema (Frank Elgar), the sciences (François Le Lionnais), and technology (Jacques Bergier). For the sciences, F. Le Lionnais gives a picture of the most important historical and scientific events during the last 50 years anddeals, in various places, with the interaction of science and society. For technology, Jacques Bergier particularly emphasizes the conquest of energy the great chemical syntheses, and telecommunications.

879 Valéry, Paul, Lecomte, Georges, Gaultier, Paul, Borel, Emile, Fabry, Charles, Caullery, Maurice, Roussy, Gustave, Hourticq, Louis, Samazeuilh, Gustave, Calvet, Jean. *La France et la civilization contemporaine. "Bibliothèque de philosophie scientifique".* Paris, Flammarion, 1941. 16mo, 333 pp.
A statement of contemporary intellectual and scientific activities in France: tendencies, techniques and prospects. The following chapters are of particular interest: "Contemporary French Mathematics" by Emile Borel; "Contemporary French Physical Sciences" by Charles Fabry; "The Biological Sciences in Contemporary Science" by Maurice Caullery; and "Contemporary French Medical Sciences" by Gustave Roussy.

880 Bouligand, G., Brunold, Ch., Grumbach, A., Morand, M., Sergescu, P., Taboury, M., Turpain, A. *L'évolution des sciences physiques et mathématiques. "Bibliothèque de philosophie scientifique".* Paris, Flammarion, 1935. 16mo, 266 pp.
Series of essays illustrating the guiding factors (*polarités directrices*) in the evolution of science. In an introduction, G. Bouligand and Ch. Brunold state that the instability of theories arises from the major "unit versus plurality" conflict. The educational role of the history of sciences is upheld as well as reciprocal exchange between individual and collective research.

881 "La synthèse idée force dans l'évolution de la pensée". Quinzième semaine de synthèse. *Revue de synthèse.* January-June 1950. Paris. 238 pp.
Contribution to the history of scientific thought. One of the main ideas emerging from these articles is that science has always aimed at unity, but that this conception of unity has evolved from an easy unity and from a synthesis (philosophic rather than mathematical) to a unity which respects "the axioms peculiar to each science" (d'Alembert) and which is constituted on the positive plane. The list of articles is as follows: the scientific contribution of Antiquity (E. Bréhier), the scientific contribution of the Renaissance (A. Koyré), the role of Bacon (P. M. Schuhl), Gassendi and the Syntagma Philosophicum (B. Rochot), Descartes and the Cartesian outlook (A. Cuvillier), Academies and Salons in the eighteenth century (Suzanne Delorme), the Encyclopaedia of Diderot and d'Alembert (P. Vernière), the Positivist synthesis of Comte and Spencer (P. Ducassé), the Materialist synthesis (J. Benda), and the synthesis of knowledge and history (H. Berr). The first 60 pages of this number are devoted to the 50th anniversary of the review.

882 *Annales: Economies—Sociétés—Civilisations.* Published with the collaboration of the Centre national de la recherche scientifique and of the Sixth Section of L'école pratique des hautes études. Managing Committee: L. Febvre, F. Braudel, G. Friedmann, Ch. Morazé. Edit. Armand Colin.
A quarterly review founded in 1929 by Lucien Febvre, Member of the French Institute, and Marc Bloch, Professor at the Sorbonne, who was shot by the Germans in 1944. Contains articles and notes on questions relating to the history of civilization, sociology, human geography, etc., and numerous bibliographical abstracts.

883 *Archives internationales d'histoire des sciences.* Published by the Académie internationale d'histoire des sciences, 12, rue Colbert, Paris 2e, with the assistance of Unesco. Editor: Pierre SERGESCU. Printed by Hermann et Cie, 6, rue de la Sorbonne, Paris, 5e.
A quarterly publication containing articles and reports written for the most part in French. It includes original articles on special questions of scientific history, new papers, etc., important book criticisms, notes and news items.

884 *Atomes.* Scientific aspects of a new age. Editor: Pierre SÜE, 13, rue Racine, Paris 6e.
A monthly review, founded in 1946. It contains serious popular scientific articles and book reviews.

885 *Cahiers d'économie humaine.* Editors: L. J. LEBRET and R. DELPRAT, 9 rue Mulet, Lyon (I).
Quarterly published by the Centre for Research on Social Trends, *Economie et Humanisme.* Contains articles, technical notes and documents. The subject of the first number, which appeared in 1951, was the evolution of rural life as a result of technical changes during the last hundred years. Policy—Christian.

886 *Cahiers internationaux de sociologie.* Published with the collaboration of the Centre National de la Recherche Scientifique and under the auspices of the Sixth Section of L'Ecole pratique des Hautes Etudes. Editor: Georges GURVITCH. Publishers: les Editions du Seuil, 27 rue Jacob, Paris 6e.
Published twice a year, in two *Cahiers* of 192 pages. Founded in 1947. Contains original articles and reviews of books on all sociological and psycho-sociological subjects.

887 *Le diagnostique économique et social.* Editors: L. J. LEBRET and R. DELPRAT. Evreux, par Arbresle (Rhône).
Monthly review published by the Centre for Research on Social Trends, *Economie et Humanisme.* Studies on present-day economic and social problems both in France and abroad. Policy—Christian.

888 *Endeavour.* A quarterly review recording the progress made by science in the service of mankind. Chief Editor: E. J. Holmyard, Imperial Chemical Industries, Nobel House, Buckingham Gate, London, S.W.1.
Endeavour is published in English, French, German, Spanish and Italian. It is not on sale, but copies are sent to libraries in the main cultural and university centres. It contains both original articles and book-abstracts. It is illustrated by outline drawings and excellent black-white and colour photographs.

889 *International Social Science Bulletin.* Published by Unesco, 19 avenue Kléber, Paris 16e.
A quarterly review, founded in 1949. It publishes articles on the various social sciences, especially sociology, and includes a non-critical bibliography of books and reviews.

890 *La nature.* Review of science and its applications. Publisher: Masson et Cie, 120 bd St. Germain, Paris 5e.
Monthly, illustrated popular science review. Publishes frequent articles on large-scale public works (electrification of the Rhône valley, etc.).

891 *La pensée.* Review of modern rationalism. Art—Science—Philosophy. Editorial Board: F. JOLIOT-CURIE, Nobel Prize, member of the *Institut*, Dr. H. WALLON, M. PRENANT, G. TEISSIER, F. JOURDAIN, G. COGNIOT, P. LABÉRENNE, A. PARREAUX. 64 boulevard Auguste-Blanqui, Paris 13e.
Founded in 1939 by Paul Langevin and G. Cogniot, this reviews appears every two months. Contains studies, notes, documents and critical analyses on all subjects connected with the arts, literature and science. Policy: Marxist.

892 *La revue de géographie humaine et d'ethnologie.* Editors: Pierre DEFFONTAINES et André LEROI-GOURHAN. Publisher: Gallimard, 5 rue Sébastien Bottin, Paris 7e.
Founded in 1948, this review was to be published quarterly. Its publication was suspended in October 1949. Articles, reports and essays on primitive civilizations and Western civilizations. Reviews of books. Numerous illustrations.

893 *Revue de l'institut de sociologie.* Published by the Institut de sociologie Solvay, Parc Léopold, Brussels.
A quarterly review, the successor to the *Bulletin et archives sociologiques*, founded by E. Waxweiler in 1910. It publishes studies of social, economic and population problems, and devotes considerable space to news of scientific developments. Book reviews and an extensive bibliography.

894 *La revue des questions scientifiques.* Published by the Société scientifique de Bruxelles and by the Union des Catholiques français, 11 rue des Recollets, Louvain (or 1 rue de la Visitation, Paris).
Quarterly containing original articles on the progress made in different branches of science, and a full bibliography of books in French, English and German.

895 *Revue de synthèse.* Published by the Centre International de Synthèse. Editor: Henri BERR, Hôtel de Nevers, 12 rue Colbert, Paris 2e. Publisher: Albin Michel.
Founded in 1900, the *Revue de synthèse*, which in theory is a quarterly, is published in two volumes each year, with a total of 400-500 pages. It contains articles in the nature of scientific syntheses and (especially) historical and philosophic syntheses. In the book-review section there is a part specially reserved for the "Philosophy of Sciences".

896 *La revue scientifique.* Published in collaboration with the Centre National de la Recherche Scientifique. Editor: Jean DUHEM, 4 rue Pomereu, Paris 16e.
This review, founded in 1863, is intended to be issued quarterly. It contains original scientific memoranda on various branches of science, studies of present-day scientific progress, and book-abstracts. A de luxe publication. Illustrated.

897 *Scientia* (Science Review). International review of scientific synthesis. Asso, Como, Italy. Editor: P. BONETTI.
Monthly review founded in 1907. Publishes articles in the original languages, with, appended to the main text, a supplement containing complete French translations of all articles written in languages other than French. Contains summarized articles on new and important aspects of all branches of science: scientific philosophy, history of science, mathematics, astronomy, geology, physics, chemistry, biology, psychology, history of religions, linguistic anthropology. These articles sometimes take the form of surveys: (determinism, relativity, vitalism, etc.). Also contains large numbers of abstracts of scientific works.

898 *Thalès.* Published by the Institut d'histoire des sciences et des techniques, 13 rue du Four, Paris 6e. Editor: Pierre DUCASSÉ. Printed by the Presses Universitaires de France.
Founded in 1934, this publication comes out in the form of an annual compendium of the work of the *Institut d'histoire des sciences et des techniques*, which makes a study of science and technology in relation to the history of thought and of civilization. Its publication is rather irregular; five issues have so far appeared: 1934, 1935-1936, 1937-39 and 1948. Besides original articles, it publishes critical bibliographical notes.

AUTHOR INDEX

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